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THE TRAVELLING SCHOLAR AND INTERNATIONAL UNDERSTANDING

IN spite of all the restrictions on the free movement of men of science imposed in recent years by American visa policy, belief in the free movement of the individual scientist or scholar has always been a cardinal principle of American political philosophy, as was well demonstrated in the Berkner Report, "Science and Foreign Policy". The value of much freer movement of scientists and other scholars or students was urged by Dr. J. B. Conant in an address to The Pilgrims in London a year or so ago. Dr. Conant made an eloquent plea for greater understanding between scholars and administrators in the universities of the United States and English-speaking countries of the Commonwealth, and a strong American delegation was invited to the Congress of Universities of the Commonwealth at Cambridge last July. At that Congress the importance of academic mobility was discussed at a session on the second day, which issued in a recommendation that the universities of each Commonwealth country should seek suitable opportunities for approaching its government with a request that it should contribute to a co-operatively administered Commonwealth interchange fund to enable the present pilot scheme to be continued and expanded.

Meanwhile, there have been some encouraging signs that the value of such interchange is more widely appreciated. The recent celebration of the Rhodes centenary has directed attention to the contribution which the Rhodes Scholars have made in this way, not merely to the world of education, scholarship and research but also in the world of affairs. The third annual report on the Fulbright programme in the United Kingdom and Colonial Territories* and the White Paper dealing with the proposed arrangements for the administration of the Marshall Scholarship Scheme† also illustrate present interest in this subject.

The Fulbright Act, it may be recalled, authorizes educational exchanges between the United States and more than twenty-five countries, providing that foreign currencies received by the United States in payment for overseas war surpluses may be used for paying the expenses of United States students, teachers, professors and specialists selected to spend six months to a year, or more, at educational institutions abroad, and to pay travel expenses to the United States of foreign nationals selected to spend similar periods in the United States. The National Academy of Sciences with the National Research Council have accepted specific responsibilities in selecting candidates for awards and in guiding the programme; and although it is only five years since the first students were appointed, a carefully co-ordinated system of operation, extending to twenty-seven countries in

* The Third Annual Report on the Fulbright Program in the United Kingdom and Colonial Territories, 1951–52. Pp. 70. (London: United States Educational Commission in the United Kingdom, 1953.)

† United States No. 2 (1953). Proposed Arrangements for the Administration of the Marshall Scholarship Scheme. Pp. 9. (Cmd. 8846.) (London: H.M. Stationery Office, 1953.) 6d. net.

Europe, Asia, Africa and the Pacific, has been developed. The Commission operates the only two-way university educational exchange between the United States and the United Kingdom, though the restriction of assistance to British citizens to travel-grants means that the American programme is the larger of the two. As a result, however, of the interest, co-operation and support of the United States Government under the Smith–Mundt Act, and of many American universities, colleges and private foundations, there were during 1951–52 more Britons studying and lecturing in the United States than there were Americans pursuing similar interests in the United Kingdom.

The third annual report of the Fulbright Commission, which covers the academic year 1951–52, is this year based on the individual statements submitted at the end of the year by each of the 760 individuals who were awarded grants during the year. As a result, the report gains a vividness that reveals more of the implications and far-reaching effects of the scheme than could well be possible in a summary prepared by the Commission itself. The broader aspects are sufficiently indicated in the introduction, while the report also includes an account of the very successful experimental five-week American Studies Conference at Cambridge in the summer of 1952.

During the year under review the Commission has consistently stressed the need for assisting applicants in such fields as adult education, social work, public health, nursing, labour relations, librarianship and curatorship in museums and art galleries, which would ordinarily seem to lie somewhat outside the terms of reference under which the Commission has been operating. Most of the funds are spent on American postgraduate students, research scholars and lecturers, who are placed at universities and research institutions in the United Kingdom and in the Colonies. Most of these 191 graduate students, affiliated with twenty-three universities in the United Kingdom, were attached to the University of London, in view of the large amount of original research material to be found in the British Museum and the Public Records Office. The one major difficulty, on which Mr. S. C. Roberts, Master of Pembroke College, comments in a personal conclusion as a member of the Commission, is difficulty in selecting not more than forty students from the large number of applicants for a second year as Fulbright Scholars.

The comments of those receiving awards illustrate strikingly the value of such interchanges in promoting international understanding and in stimulating intellectual effort to which Lord Reading testified in respect of the Rhodes Scholars when the Marshall Aid Commemoration Bill received its second reading in the House of Lords. Lord Reading spoke with appreciation of the effect of the alert and mature outlook of Rhodes Scholars from the United States on the more casual and callow minds of British students. But the effect is reciprocal; the post-graduate Fulbright Scholars expressed their appreciation of the freedom from too direct supervision typical of the British universities, and offered special praise for the tutorial system and for the chance of detailed and informal discussion with an expert.

Some of the comments are of special interest in regard to current discussion in Great Britain on the character of university education. With agreement as to the great advantage of the tutorial system and the challenge offered by lack of direct supervision goes a comment that these were a disadvantage to the young student wishing to have a general survey of a subject. It was also observed that while the British student came to the university better prepared than the American, specialization, especially in science, began too soon and the British student of science had only a meagre interest and background in subjects such as history, literature and philosophy. The British student was also considered to be more serious, sober-minded, polished in expressing his ideas, but often less open-minded and less inclined to challenge the views of his teachers. Of the tutorial system, again, it was held that, besides giving the mastery of facts, it encouraged greater originality of thought and expression, stimulating the creative intellect and training the all-important critical faculty, with the result that a certain intellectual maturity resulted which the American system found it difficult to emulate.

Of thirty-eight awards to senior Americans in 1951, seventeen were to lecturers and twenty-one to advanced research scholars. Most of this group thought that the greater specialization demanded of the British undergraduate was far better preparation for graduate work than the more diffuse American undergraduate programmes. The lack of direct supervision and the absence of frequent tests and examinations were interpreted as benefiting the gifted student only. A specific comparison of Cambridge with American laboratories, based on the experience of a biochemist, noted the crowding and lack of equipment but also that such conditions were conducive to the interchange of ideas by informal discussion. Nor was it considered entirely a misfortune that British laboratories to-day are much less lavishly equipped than those in the United States: it is suggested, for example, that it was no accident that the important technique of paper chromatography was developed for the separation of complicated mixtures of amino-acids in Britain in the midst of all its shortages towards the end of the War, rather than in the United States.

Thus, echoing the remark of Lord Rutherford which Sir Henry Tizard has made familiar, not only improvization and its implications are welcomed, but also the more leisurely attitude to work of the British scientist. The Fulbright Scholar is confident that this more leisurely attitude helps to foster the unconscious processes that lead to creative thought. Here he has the support of ample authority from those who have inquired into the matter, and his experience has also convinced him that we are at least holding our own in the production of the germinal ideas that set thought and experiment on new paths.

On the British side, 313 awards were made to British lecturers, research scholars and graduate

students, and partial awards to 102 British secondary school teachers, to cover the cost of return travel between their homes and American institutions of higher learning. It will be apparent how large is still the field to be covered by such means as the fellowships sponsored by the Nuffield Foundation, the English-Speaking Union, the Rotary International and other bodies, when all allowance is made for the assistance given by private American foundations, scholarships and fellowships offered by American universities and colleges and private or other means, if the candidate is to prove possession of the dollar funds for maintenance in the United States which is a condition of an award. The work of the Commission was made more fully reciprocal as between Britons and Americans when in 1949–50 the Smith–Mundt Act allowed appropriation of funds to provide grants in dollars for those candidates wishing to study in the United States and whose applications were successful in the open competition held annually in the United Kingdom.

Most of those who went to America returned with a completely different outlook on the United States, though unless the American university department was ready to make allowances for a higher degree of specialization, the British student tended to feel frustrated academically, because of the slender allowance for independent work. This criticism did not apply to the courses in science or technology. The senior British scholars and lecturers were greatly impressed with American kindness and generosity, and some drastically revised their entire approach to American education. They were impressed by the high quality of lectures and, in science, with the equipment available for research, though opinion was expressed that the research student in America would benefit with a little more reflexion and a little less action. The eagerness of research organizations and universities to learn about recent research in Europe, to discuss British school and university training, to gain an insight into the educational background of British research workers, to learn how research projects are financed in the United Kingdom and how a balance is struck between expenditure on pure and applied research were noteworthy.

Such personal impressions reveal most vividly the human significance and potentialities of the Fulbright programme and such interchanges generally. This report, however, covers only exchanges between the United States and the United Kingdom and the Colonial Territories. It is only a part of the programme in which during 1951–52 some 1,500 American citizens and 2,500 citizens of twenty-seven countries were selected for awards.

Despite the complexity of the administrative structure and its dependence on inter-group and international co-operation, the Fulbright programme has grown steadily in strength during the past five years: its administrative structure has proved sound and it works. The advice and support of outstanding American scholars has been obtained in maintaining the competitive character and professional quality of the selection process, and in promoting confidence in the programme abroad; there are apparently not enough qualified American candidates of the lecturer category to meet the needs of the programme.

There is already abundant testimony to the effectiveness of the programme in realizing its primary objective of promoting intercultural communication and understanding; and by adopting the proposal for founding at British universities twelve scholarships to be competed for annually by American students—a proposal which Mr. Herbert Morrison, as Foreign Secretary, was largely responsible—the Government has made possible another fine contribution to international friendship. The only criticisms of the scheme made in the debates related to its size in comparison, for example, with the Fulbright programme, and there was some anxiety that the scheme should cover so far as possible all universities of the Commonwealth, and that if possible the Marshall Scholarships should be distinctive in some way—either in regard to creative work or to some special field of study such as British political or social institutions.

The scheme proposes to create a Commission in the United Kingdom to administer the funds provided, to approve the selection of the scholars, to assist in placing them in British universities and to supervise their general welfare. An Advisory Council in the United States will make nominations to the Commission for the awards, on the basis of the recommendations of four regional committees, which will make selections of candidates for three scholarships each from broadly equal geographical areas. In selecting Marshall Scholars, regard will be had both to academic qualifications and to qualities of character and leadership. The value of a Marshall Scholarship will be £550 per annum, but may be increased up to £600 per annum or by £200 per annum for a married man. It is estimated that the maximum annual expenditure will be about £37,000 in the United Kingdom and 10,500 dollars in the United States; but this level will not be reached until the cost is incurred of the return passages to the United States of the first Marshall Scholars, who are expected to be received for the academic year 1954–55. The scholarships will be tenable for two years in the first instance, but may be extended at the discretion of the Commissioners.

The proposals submitted in July to the Congress of Universities of the British Commonwealth by Sir James Mountford, vice-chancellor of the University of Liverpool, arose out of a pilot scheme operated during the past five years in consequence of a resolution passed at the Congress in 1948. During this period the Commonwealth Relations Office of the United Kingdom, acting through the British Council, had provided more than £30,000 for 194 grants for academic travel, in which 58 university institutions had participated. The scheme, however, was inadequate: the Colonies were not included, and no provision was made for interchange between overseas countries of the Commonwealth. As already indicated, it is now proposed to invite the co-operation of all Commonwealth Governments, and a minimum of £25,000 a year is required.

Strong support for the whole idea of academic mobility was given at the Conference, virtually the only opposition coming from the University of Montreal, the representative of which, Dr. M. Faribault, contended that a Commonwealth Interchange Fund, co-operatively administered, would be unworkable. Even he, however, urged that Governments should make grants for academic travel, and the overwhelming majority of the Congress was concerned with the means by which in practice academic mobility could be fostered and organized as well as financed. The importance of such interchange for the under-developed countries was emphasized, and behind the recognition of the desirability of making it possible for a university teacher to take a post anywhere in the Commonwealth without detriment to his career, there was implicit the consciousness of the immense importance of the contribution to mutual understanding which could be made in this way.

Besides the resolution urging government support of a Commonwealth Interchange Fund, the Congress passed a resolution recommending co-operation in superannuation arrangements in such interchanges. Within the Commonwealth the chief obstacles to academic mobility are administrative and financial, and as such are primarily the concern of the universities themselves. The universities are, however, already pledged to co-operate in working the Marshall Scholarship scheme; but it is evident that if this intellectual migration is to grow to an extent which will enable its full potentialities to be realized, further financial support must be forthcoming from the Government. Moreover, there are also obstacles, like visas as well as currency, which only government action or public opinion can overcome.

The report from the Fulbright Commission indicates clearly how much the universities of both Britain and the United States have to gain from this two-way traffic. It is already apparent that the experience of Fulbright Scholars may make important contributions to some of the current problems of British universities, to which the University Grants Committee directed attention in its recent report, notably those arising out of the lack of cultural background or interests. The same report, like the discussions at Cambridge, indicated also how much such interchange could contribute towards providing the technical and cultural leadership and mutual understanding so urgently needed in the backward or undeveloped territories, and how far-reaching are the benefits of academic mobility and the free passage of ideas whether by the wandering scholar or the unimpeded circulation of books and periodicals which Dr. Conant's academic 'grand alliance' could foster.

It will, of course, be pointed out that besides the Fulbright scheme and the Rhodes scholarships there are already numerous organizations functioning in this field. The Nuffield Foundation, like the Rockefeller, the Guggenheim and the Carnegie Foundations, has devoted considerable funds to travelling fellowships and scholarships, and it may be noted that Rhodes Scholars are at the head of the last three bodies. For nearly thirty years, the Commonwealth Fund Fellowships have been sending British students to American universities, and the six hundred or so returned Fellows have played a part in furthering international understanding quite as important as have the Rhodes Scholars. The English-Speaking Unions both of Britain and of the United States send students from Great Britain to the United States, and the King George VI Memorial Fund raised by the latter is to be devoted entirely to this purpose.

Perhaps the most hopeful feature of the debates on the Marshall Aid Commemoration scheme is the indication that the possibilities inherent in such academic migration are catching the public imagination. If the regret then expressed that the scholarships were so few is in the least sincere, the Government should be able to count on a generous response if it asks Parliament to vote supplies for such a Commonwealth Interchange Fund as was recommended at the Universities' Congress. The Rhodes centenary celebrations should facilitate the task of public education; but in the present economic circumstances of Great Britain, it is incumbent on all who appreciate the significance of such schemes—alike for Britain's own trained man-power and economic development, for Colonial development and welfare, for Commonwealth resources and for mutual understanding not only in the Commonwealth but throughout the world—to see that no opportunity is missed of bringing home to governments and peoples the immense advantages which they could bring to the nation as well as to the universities. The third report of the Fulbright Commission contains material which could be widely used to that end, and shows what hopes may justly be placed in co-operation based on mutual understanding, respect and trust.

FACTS (AND FANCIES) OF LIFE

The Facts of Life

By Prof. C. D. Darlington. Pp. 467 + 9 plates. (London: George Allen and Unwin, Ltd., 1953.) 35*s*. net.

THE purpose of this entertaining book by the recently elected Sherardian professor of botany in the University of Oxford is, in his words, "to show the immense possibilities which await the application of the elementary principles of heredity (or, as we call it, genetics) to the great problems of society—of education, of medicine, of crime and punishment, of marriage and divorce, of the relations of races and classes, and, taking a long view, of evolution".

The method adopted is to give first a historical outline, with commentary, of genetics, stressing the curiosa and exotica of the history of reproduction and the battles of ovists and spermists, of Mendelians and biometricians, and similar lively encounters, culminating with an account of genetics in the U.S.S.R. and an excursion on fraud, all told with wit and an ear for the sound of words. The second half of the book discusses the human problems referred to above, arriving finally at a biological interpretation of history.

The central theme which gives some unity to the very diverse subject-matter is the author's concern with genetic determination, by which he means on

one hand that the reactions of the living individual with any given set of outside events "are decided before they occur and can be predicted". "On the other hand, we mean that taking all possible circumstances into account and allowing for an infinite variety of circumstances, there are certain limits to what the product of a particular fertilized egg can do, and these limits are laid down by the chemical and physical structure of that egg." The chief instruments of genetic determination are the genes; and although Darlington indicates an acceptance of the interaction between the genotype and the environment, he sometimes forgets the cardinal principle that although genes are uniquely determined, subject only to the uncertainty of mutation, phenotypes are jointly determined, and he speaks as though it was the character which was uniquely determined.

This kind of genetic determinism can run rampant and does. Darlington supposes not only that "the gradation between the most helpless of mortals and a Caesar (or a Newton or a Shakespeare) is a genetic one" (p. 302), but that classes of men are also genetically differentiated, and gives his adherence to Plato's "noble lie" as a description of human society as it has always been. Unlike his Greek predecessor, however, he makes it quite clear where his sympathies lie. "In England, for example, it is not lack of research which limits food production but the genetic unfitness of a large part of the tenant farmers, the legally secured occupiers, who are organized to keep better men off the land" (p. 356). It is not surprising, therefore, to find him adopting the same position with respect to racial differences. Speaking of the advantage of the White-plus-Negro society of the southern United States over a Negro society alone and over the Indian society which had been displaced, he says: "Their capacity and his [that is, the Indian's] capacity are both of course racial and genetic. They are determined and limited by heredity" (p. 293). It should be pointed out that in introducing such matters the question is begged at the very beginning, for he says in speaking of the apparent backwardness of the "Australian blackfellows" that it "is supposed to be due largely to their inadequate heredity". There are other evidences of the same substitution of opinion for exposition. "Some men are born to command and others to obey and others again are intermediate" (p. 267). "Each individual has his own genetically determined character of speaking" (p. 287). "Economic circumstances alter the expression of vices as well as virtues. But in themselves they play little part in creating them" (p. 267).

The whipping-boy for the views of human society which do not stem from genetic determinism is a composite creature called the social scientist, who "has thus come to take his stand on the view that groups of human beings differ in culture which has been handed down to them through the accidents of education" (p. 243). To which many a non-social scientist would remark: "Well, so they do". The social scientist has apparently been set up by the author to defend those views which he will later claim to be wrong.

The application of scientific knowledge, of facts, takes place through technology. The author of this book has aimed at something beyond this, at the application of principles, of understanding, to the great human problems. In this sense what is to be 'applied' is a point of view acquired from the study of heredity, and this should include the scepticism, the caution in relating conclusions to data, the exercise of critical judgment which are goals as well of legal as of scientific training, as they relate to matters of evidence. Lawyers who conduct their investigations and build their case in accordance with these principles have been known to forsake them in summing up to the jury, when eloquence and special pleading tend to leap over the limits of fact. We may be reminded again by this book that scientists run the same risk. As an exposition of the author's philosophy and of his thoughts on the implications of his science, this book is brilliant, interesting, amusing, and irritating. His colleagues, using both grains of salt and pepper, will savour it. As for the public, it is perhaps not necessary to have a similar degree of scientific sophistication to appreciate it; but it would be a wise precaution.

L. C. DUNN

SCIENCE AND THE SOCIAL ORDER

Science and the Social Order
By Bernard Barber. Pp. vii+288. (London: George Allen and Unwin, Ltd., 1953.) 20*s*. net.

THIS book immediately recalls Prof. J. D. Bernal's "The Social Function of Science" or J. G. Crowther's "The Social Relations of Science"; and apart from the shorter range of historical perspective, at least in detail, as compared with Mr. Crowther's book, and a concern with the American rather than the British scene, its scope is essentially the same as that of the earlier books. Mr. Barber is at pains both to be scrupulously objective and also to supply the reader with the means for verifying and examining his statements or comments. Though the bulk of the references, more especially those to recent articles, are to American sources, he appears to have missed little of importance, and his book is both suggestive in itself and a sound introduction to the more important literature on this subject, particularly of the last two decades.

Although the main theme of the book is that of Bernal and Crowther's earlier books, the treatment is entirely different. After briefly discussing the nature of science in his introduction and explaining his reasons for treating it systematically as a social activity, Mr. Barber examines the place of rationality in human society and sketches the historical process of the evolution of science and the social influences in that evolution. Next, he reviews the place of science in both liberal and authoritarian society, and a general discussion of the social organization of science itself leads him to the closer view of science in American society already noted. Four of his eleven chapters—about a third of the book—consider successively the social organization of science in the United States and the scientist in the American university and college, in industry and business and in the government. In his last three chapters, Mr. Barber gives a brief sketch of the social process of invention—suggestive rather than adequate—in which the role of the individual and society in scientific discovery are appraised; discusses the social control of science, from the point of view of the social responsibilities and consequences of science and the possibility of planning science; and, finally, attempts to assess the nature and prospects of the social sciences.

The book will appeal to those who are concerned to arrive at a reasoned view of the relations between science and society, rather than to cull material in support of a particular political theory or other preconceived idea. Mr. Barber has definite views on the place of science and the social order, but they are not obtrusive. While he is careful to state fairly the pros and cons in any controversial issue, such as the planning of science, his writing is refreshingly free from bias and the urge to advance a particular point of view, and with a certain rather charming persuasiveness seeks to stir the reader rather to make his own independent judgment, even by seeking further facts. Complete in itself, the book does not purport to be more than an introduction, and while in some chapters, notably that on the scientist in the American government, it presents with remarkable accuracy and skill the quintessence of a long series of voluminous reports, its selection and judgment can easily be verified. The busy reader may welcome the reliability and accuracy of this compression; those able to probe further will find the way made easy. R. Brightman

COTTON YIELDS IN EGYPT

The Yields of a Crop

Based on an Analysis of Cotton-Growing by Irrigation in Egypt. By Dr. W. Lawrence Balls. Pp. xv+144. (London: E. and F. N. Spon, Ltd., 1953.) 21*s*. net.

IT is not often that agricultural science is presented with the distilled wisdom gathered from an intimate acquaintance with forty-four generations of an economic plant. Yet this is what Dr. Lawrence Balls has given us in this classical account of the history of cotton yields in Egypt. The author's unique contribution to the study of the behaviour of cotton in the field is in the domain of methodology. The cotton plant is especially suitable for studies in field physiology by reason of the fact that yield is built up first by the number of flowers which the plant produces, expressed as "flowers per plant per day" and later as "bolls per plant per day". The plant thus acts as an integrator of the complex environmental conditions under which it has been grown. This powerful method enables the usual procedures of the statistician either to be abolished or supplemented, according to the special psychological orientation of the observer.

In recent years two major sets of factors have interacted in a complex way to affect the yield of the cotton crop in Egypt.

On one hand there has been a rise in the water-table which has progressively diminished the volume of soil available to the roots of the crop. On the other hand, notable improvements have been effected in agricultural techniques by the author and his colleagues. Plant breeding, soil chemistry and entomology have all played a part in the augmentation of yield. But by a masterly process of first evaluating and then discounting these favourable factors, the author clearly demonstrates by a wealth of graphical data that the yield of cotton in Egypt is going down and that a vast engineering project is necessary to mitigate the effects of one simple factor, namely, that for many years the cotton crop has been getting a lot more water than is good for it. In other words, "the whole technique of Egyptian irrigation would have to be re-designed and largely re-learned from the beginning, in small details of maintenance as well as in great constructional works". It is certainly true also of some other cotton-growing countries such as Peru. The author demonstrates that crop physiology needs the employment of a variety of disciplines for the solution of its special problems. In his analysis he has made use not only of facts from plant physiology, but also from irrigation engineering, meteorology, soil chemistry and physics and entomology. Few agricultural scientists are equipped with the necessary background to do this; but they may at least profit by the author's insistence that "the invisible root is of equal importance with the visible stem, and that better methods are needed for its study".

Finally, tribute must be paid to the magnificent prose which the author writes whenever the omission of technical detail permits. S. C. Harland

LIME IN AGRICULTURE

The Use of Lime in British Agriculture

By H. W. Gardner and H. V. Garner. (Agricultural Series.) Pp. xv+216+12 plates. (London: Farmer and Stock-Breeder Publications, Ltd., and E. and F. N. Spon, Ltd., 1953.) 26*s*. net.

IT is commonly accepted that the most important single factor responsible for crop failures and reduced crop yields in British agriculture is the low lime status of many of our soils. For this reason, agricultural teachers and advisers have for many years emphasized the importance of adequately liming soils which show deficiency, and the authors of this book are to be commended for focusing attention on this major problem.

Addressed primarily to present and future farmers, the book admirably presents a comprehensive survey of the liming problem, covering in its eleven chapters the agricultural aspects, the development of soil acidity and assessment of lime requirements, the sources and production of liming materials and the effects of lime applications both on crop yields and crop composition.

The first chapters present the problem facing the agriculturist of the present day, followed by a historical survey of liming, culminating in the decline of the once-popular practice of heavy applications, and a discussion of the benefits to be obtained by judicious applications of lime to deficient soils. The rather ill-defined usage of the term 'lime' in the agricultural world is clarified and the relevant chemistry of the simple calcium compounds discussed to enable the non-scientific reader to follow successfully the somewhat complicated reactions occurring in the soil. A digressionary chapter on *p*H and its measurement should be helpful to enable the scientifically inclined reader to appreciate the significance of what, to many practical agriculturists, is simply a convenient and apparently arbitrary convention for indicating degrees of soil sourness. Apart from these slight excursions into the realms of pure science, the book is essentially based upon practical experience and interpretation of field experiments, and it is especially valuable on this count. The assessment of losses of lime from the soil under natural and husbandry conditions, the effects of liming on arable rotations and on grassland of various types are fully supported by experimental

evidence drawn from many centres throughout Great Britain.

Apart from the more obvious effects of an adequate soil lime status upon crop yields, the important influence it has upon the mineral status of forage and other crops, and hence upon animal nutrition, is described with several illustrative tables in the last chapter. An appendix to the main text contains a number of statistical tables and a miscellany of useful data, and there is an adequate index.

Each of the chapters has an attached reference list which should enable the inquiring reader to pursue the subject-matter in greater detail if necessary.

The book is well written and produced, and can be recommended not only to the farmer but also to the student of agriculture, while the teacher and adviser will find much of value condensed within its pages.

W. N. TOWNSEND

GLOSSARY OF COLLOQUIAL AND DIALECT ROCK TERMS

English Rock Terms

Chiefly as Used by Miners and Quarrymen. By Dr. W. J. Arkell and Dr. S. I. Tomkeieff. (University of Durham Publications.) Pp. xx+140. (London: Oxford University Press, 1953.) 21*s*. net.

IN this little book the authors have striven to record and explain the many colloquial and dialect words still commonly used by quarrymen, miners, farmers, boring contractors and others that are either not found in standard dictionaries or are not there accorded the special sense in which such craftsmen use them. The terms included are those used for describing rocks in the widest sense, rock units and structures affecting rocks. Modern scientific rock names, such as those ending in -ite and those based on place names, are, with few exceptions, omitted. Though they list the principal glossaries consulted, the authors emphasize that their aim has not been to make a compilation from these glossaries but to collect terms from their original sources in early works on geology, mining and natural history.

The preparation of this work has extended over a number of years, and it is evident that the sources consulted extend far beyond the limits of the glossaries listed. The "Oxford English Dictionary" and the "English Dialect Dictionary" have been consulted in respect of every entry. With most entries, source references to early usage are given and, frequently, etymological notes, too. There is also a subject index of the terms included.

The text has been read by Prof. Bruce Dickins, who contributes a preface. In this he points out that, though every craft has its specialized vocabulary, this is rarely recorded in literary use and sparsely recognized even in the great dictionaries. The authors have remedied this defect in so far as geology, mining and related crafts are concerned.

There is always the temptation, in examining a work of this sort, to look for errors of commission and omission—it would have been interesting, for example, to have included a definition of Haggis Rock for comparison with that of Puddingstone—but this would be quite unfair to the compilers. They have performed a most useful service in making available to the public, in book form, the results of their researches. One mild criticism is offered. The title may be regarded, by some, as misleading, and is calculated to bring down the wrath of the Scots, not to mention the Welsh and Irish, on their head. The rock terms include many of Scottish, Welsh and Irish origin, so that the book might more aptly have been entitled "British Rock Terms". This apart, it can be recommended as likely to prove useful to geologists, mining engineers and others whose work brings them into practical contact with geology. It may well prove of interest to philologists, too.

V. A. EYLES

CARING FOR THE OLD

Our Advancing Years

An Essay on Modern Problems of Old Age. By Dr. Trevor H. Howell. Pp. 192+28 plates. (London: Phoenix House, Ltd., 1953.) 16*s*. net.

IN this book Dr. Trevor H. Howell has given a very comprehensive picture of the organizations caring for the needs of old people in Great Britain at the present time. Since the whole problem of an ageing population has only recently been brought forcibly to light, many palliatives and plans are still in the nature of experiments. Throughout the book it is clear that there is grave lack of co-ordination of the services provided, resulting in wastage and inefficiency. Dr. Howell's recommendations, therefore, of a unified service for old people throughout the country and co-ordination of existing facilities is of special interest.

The chapter on the aged sick should prove of great value to those laymen who are faced with the care of their infirm old relatives. It must, however, be remembered that the problems are largely sociological and only to a small degree medical. Ninety-eight per cent of the ageing population live in their own homes, most of them normal, happy old people, often indeed in need of better housing conditions, but not problem cases. Dr. Howell quotes at length Aristotle's description of the mental changes observed in older people and expresses the opinion that it is as true now as when it was written. Older people are stated to be cynical, small-minded, miserly, fearful, selfish and subject to quick, feeble fits of passion. That this is true now of any but a minority, most people will not agree. There is no redeeming feature in it—Was it ever true? Possibly the reason for this pessimism is that the happy, useful and—it might be added—normal old person is far less in evidence than those whose faults and disabilities make them obvious and difficult. But they were probably always difficult.

The rehabilitation of the old—geriatrics in medical jargon—has greatly improved, but there is little evidence in this book that much is being attempted for those old people who wear out in mind rather than in body. Many of the ills of old age are psychological rather than physical in origin and, for both, prevention is the humane and economical course. Much of the work done is, of necessity, palliative rather than curative; but unless premature ageing is anticipated and prevented, the younger part of the community may well be swamped with the effort and expense required to meet the necessities of those old people whose minds and bodies have been allowed to fail unnecessarily.

The book merits careful study and is obviously written from first-hand knowledge, especially of the medical side.

MARGARET HILL

An Introduction to the Chemistry of the Hydrides

By Dallas T. Hurd. Pp. x+231. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 44*s*. net.

THE group of compounds known collectively as the hydrides includes examples of a very wide range of chemical bonds, and therein lies much of its fascination. Until recently, no great effort had been made to look at this group as a whole; indeed, no monograph has previously appeared covering the whole field, although several well-known works dealing with small sections of the field have appeared. Dr. D. T. Hurd, who has himself made several important contributions to hydride chemistry, presents a comprehensive survey of the hydrides, including a considerable amount of descriptive and preparative chemistry.

Several chapters are devoted to a general consideration of the main types of hydride and such topics as chemical binding and acids and bases. Outside these general chapters the material is dealt with in groups, passing from the salt-like hydrides, through the hydrides of the non-metals to those of the transition elements and those of the copper- and zinc-type elements. The book is likely to be of interest both to those who are engaged in research and to those who are teaching advanced inorganic chemistry. In particular, the inclusion of a brief but adequate consideration of the well-known hydrides along with the less well-known compounds is particularly valuable, as is much of the technical information on the production and uses of certain of the hydrides. Limited reference is made to the complex hydrides such as lithium aluminium hydride. A chapter is included to cover the nomenclature of the hydrides, and the appendix deals with several topics in a very brief and sketchy fashion, for example, the vacuum manipulation of volatile compounds and the toxicology of the hydrides.

The book is well prepared and presented and contains only a few minor mistakes.

D. S. Payne

Removing the Causes of War

By Dr. Kathleen Lonsdale. (Swarthmore Lecture, 1953.) Pp. ix+76. (London: George Allen and Unwin, Ltd., 1953.) Paper, 3*s*. 6*d*. net; cloth, 5*s*. net.

PROF. KATHLEEN LONSDALE'S Swarthmore Lecture for 1953 is an attempt to analyse the causes of war and the ways in which they may be removed. Even when criticism is tempered by the qualification that her attempt is undertaken within the framework of Quaker ways of thinking and acting, the Lecture is nevertheless disappointing. Few readers will question that the wholesale conversion of the world to the Quaker doctrine of non-violence would lead to the elimination of war, even if causes of international dispute still remained. The Christian might accept the possibility of such a wholesale conversion as reasonable; but, in the meantime, it is asking rather much of the non-Christian world to rest hopes of the elimination of war upon such an assumption. Prof. Lonsdale's lecture is disappointing because she offers so few positive and constructive suggestions for the removal of the causes of war on which men and women of goodwill could co-operate further.

By and large, Prof. Lonsdale adds little to what had already found formal expression when the Kellogg Pact for the renunciation of war as a means of settling international disputes was signed, and when, in its various technical committees, the League of Nations was already demonstrating the practicability of international co-operation, given the common purpose. On technical assistance to the underdeveloped areas, she writes with realism; but there is slender guidance in these pages for the reader who looks for a clue to the resolution of the problems of power and responsibility, loyalty, law and order and their ultimate sanction in a world at so many differing levels of idealism, moral standards and physical needs.

R. B.

The Physical Chemistry of Proteins

Discussions of the Faraday Society, No. 13, 1953. Pp. 288+4 plates. (London: The Faraday Society, 1953.) 35*s*. net.

THIS volume contains the published proceedings of the symposium on "The Physical Chemistry of Proteins" which was held during August 1952 in Cambridge under the auspices of the Faraday Society. In addition to the papers, it contains the Sixth Spiers Memorial Lecture on "The Molecular Shapes of certain Proteins and some of their Interactions with other Substances", by Prof. J. T. Edsall, and contributions to the general discussion. The papers are divided into five sections: experimental techniques (recent developments); low molecular weight proteins; high molecular weight systems; protein interactions; and conjugated proteins (nucleo- and muco-proteins). Most of the papers contain accounts of original experimental investigations, though useful theoretical (for example, on muscle action and antigen – antibody reactions) and review articles (for example, on conjugated proteins) are presented. The volume covers the subject very broadly and should give a useful impression of its state of development.

The Shoreshooter

By Richard Arnold. Pp. 143+9 plates. (London: Seeley Service and Co., Ltd., 1953.) 12*s*. 6*d*. net.

IN days not so long gone every naturalist used a gun in the course of his studies of birds and mammals. To-day he more commonly uses field-glasses, observation having largely taken the place of shooting. Books about bird-watching are legion; but books about the shotgun are not nearly so many, hence Richard Arnold's volume, "The Shoreshooter", will be helpful to those desirous of using gun and cartridges in the neighbourhood of salt water. The author has set out to provide information "on the practical side of fowling, dealing with practical problems", for the man who desires sport but must consider the financial aspect. Nevertheless, he turns to the things the fowler sees, and appreciates "the glorious dawns, the perfect 'fowler's moons' ", and his "thrills to the calls of the wild geese".

Mr. Arnold deals with guns and cartridges, clothing and equipment, wild geese shooting, the shooting of ducks and waders, and has some excellent notes on waterfowl, useful alike to the man with and without a gun. The person who prefers binoculars to a gun will also find much of interest in the chapter on decoys, dogs, cooking and the law.

In conclusion, a few words must be spared for the fine illustrations from photographs by Eric Hosking. Plate 3, a crowd of dunlin on the shore, is a picture to make all wild-life photographers envious.

Frances Pitt

SCIENTIFIC CENTENARIES IN 1954

By JOAN M. EYLES

THE modern use of a surname is so well established that it is worth recalling that, as late as the fifteenth century, hereditary surnames were by no means general, it being the custom to add to the baptismal name the place of the owner's birth or residence, or his occupation or some peculiarity that would identify him. Thus we find that Hermann, an eleventh-century monk, was known as Hermann of Reichenau, after the abbey in Switzerland where he spent most of his life, and also as Hermann Contractus, or Hermann the Cripple, on account of the paralysis which had afflicted him from youth. Hermann, born in 1013, has been described as one of the most learned men of his age, and interests us particularly because he was devoted to the study of mathematics and astronomy. He was the author of a work on the abacus and two on the astrolabe, at a time when the latter instrument was almost unknown to Europe. He died in 1054, at the castle of his father, Count Wolferad of Alshausen.

Another medieval philosopher, thought to have died in 1154, was William of Conches. Born at Conches in Normandy, he was for a few years tutor to the future Henry II of England. William was a man of considerable intellectual courage and originality. He wrote a treatise on natural philosophy which drew strong criticism from the theologians, and in a revised version, entitled "Dragmaticon", he made a declaration of his right to independence of thought which was quoted with approval by later writers.

A century after the death of William of Conches, we come to the probable year of birth of Marco Polo. One could scarcely call him a scientist, but much of the information to be found in the account of his travels is of scientific interest, although at first it seemed fiction to incredulous Europeans. Marco was only seventeen when he left Venice with his father Nicolo and his uncle Maffeo, in 1271. He was a man of forty when they all returned, twenty-three years later, and in the interval he had traversed much of Asia. Employed in the service of the great Kublai Khan, he visited regions which were to remain unknown to Europeans for another five or six hundred years. Eventually he was held in captivity in Genoa, where he dictated an account of his travels to a fellow prisoner. This narrative contains details of many plants and animals strange to the West. He described the use of coal for heating, and gave an account of the mining and preparation of asbestos, a substance at that time believed to be the fur of the fabulous salamander. Marco died in Venice in 1324.

The year 1954 marks the five hundredth centenary of the birth of the Italian astronomer Domenico Maria di Novara. Born at Bologna, Novara became professor of astronomy there in 1483, and for a few years the young Copernicus was his pupil and assistant. In those days astronomy was the handmaid of astrology, and some of Novara's annual predictions, discussing such topics as wars, diseases and the crops, are still preserved.

Passing from Italy to Germany, we note the death in 1554 of Jerome Bock, the herbalist. Bock, born in 1498 at Heiderbach in Baden, was intended for the cloister, but instead became a Protestant schoolmaster and physician, spending most of his life at Zweibrücken. His great herbal, "New Kreütter Bûch", which appeared first in 1539, is remarkable because Bock was the first botanist to attempt descriptions, from direct observation, which would render illustrations unnecessary. To obtain his material he made long journeys on foot, dressed as a peasant, to avoid undue attention. Illness and misfortune clouded his later life, and he died when only fifty-six, being predeceased by eight of his ten children.

The increasing interest in the study of plants, animals and minerals manifested in the sixteenth century led to the formation of many great collections, such as that made at the Vatican by Michele Mercati, and the notable one made by Ulisse Aldrovandi, some part of which is still at Bologna. One of the most celebrated collectors of the seventeenth century was Olaf Worm (1588–1654), a Danish physician. A complete account of his collection, prepared by Worm himself, was published after his death, in 1655. It includes a delightful illustration of the interior of the museum. Many of Worm's 'curiosities' were of archæological interest, and indeed the book seems to have become a standard reference work for antiquarians of the period.

Other interesting tercentenaries of 1954 include those of the births of two mathematicians, Jakob Bernoulli and Pierre Varignon. Jakob was the eldest of the noted Swiss family, so many of whom achieved distinction in science, particularly in mathematics. Born at Basle on December 27, 1654, he became professor of mathematics in his native town at the age of thirty-three. Before this he had travelled extensively in Europe, and, while he was resident in Geneva, he became interested in the teaching of mathematics to the blind. Later, he devoted himself to developing the calculus of Leibniz, and he was a pioneer in establishing the calculus of probabilities, a subject in which his posthumously published "Ars Conjectandi" has become a classic. He and his brother Johann were the first two foreign associates of the French Academy of Sciences when it was reconstituted in 1699. Jakob died at Basle in 1705. His contemporary, Pierre Varignon (1654–1722), was born at Caen and became a professor of geometry in Paris. He was one of the three *pensionnaires* in geometry elected to the Academy in 1699. Like Bernoulli, with whom he corresponded, he was interested in the new calculus, and was one of the first French scientists to recognize its value.

Bernoulli's work on the theory of probability was followed up by Abraham de Moivre, a French Huguenot who died in London on November 27, 1754, in his eighty-seventh year. In his "Doctrine of Chances", published in 1718, he made important contributions to the mathematical basis of vital statistics. He was elected to the Royal Society in 1697 and was an intimate friend of Sir Isaac Newton. He supported himself by teaching and answering queries on games of chance and the value of annuities. De Moivre is also remembered for the theorem which bears his name.

The year 1754 was also that of the deaths of two prominent members of the Royal Society, Dr. Richard Mead on February 16, and Martin Folkes

on June 28. Folkes, born in 1690, had been president of the Society from 1743 until 1753, and was a well-known antiquary. It was during his presidency that the *Philosophical Transactions* reached a very low standard, and Sir Henry Lyons ("The Royal Society, 1660–1940") has suggested that this was directly related to Folkes's own lack of interest in scientific research. Folkes's portrait by Hogarth hangs in the apartments of the Society. Richard Mead, physician, was born in 1673 and served on the Council of the Royal Society for forty-five years. He attended many famous men, including Isaac Newton and Alexander Pope, and he was the opponent of Dr. John Woodward in a famous duel fought at the gate of Gresham College. His house in Great Ormond Street, where now stands the Sick Children's Hospital, housed a great collection of "all that was curious in nature and art". His medical works include a discourse on the plague and another supporting inoculation against smallpox.

Two others who died in 1754 were G. W. Krafft (born 1701), professor of physics at St. Petersburg, who investigated the final temperatures obtained by mixing hot and cold water, and J. Christian Wolff (born 1679), mathematician, philosopher and psychologist. Wolff was a follower of Leibniz. His rationalist views led to his dismissal from his university post at Halle by Frederick William I, who gave him forty-eight hours to leave Prussian territory, on pain of death. Many years later Wolff was recalled by Frederick the Great, and his return to Halle was marked by a triumphal procession. He became chancellor of the University in 1743 and died on April 9, 1754.

Before passing on to the bicentenaries of those born in 1754, we must note an important meeting on March 22 of that year at Rawthmell's Coffee House, Covent Garden, at which eleven gentlemen decided to form a "Society for the Encouragement of Arts, Manufactures and Commerce in Great Britain". This was the foundation of the society that became known as the Society of Arts, since 1908 the Royal Society of Arts (see p. 12). By a system of premiums and medals the Society pursued an admirable policy of encouraging both rural and industrial progress. The Society's efforts were not confined to Britain, but extended also to the Colonies and particularly, until the Declaration of Independence in 1774, to the North American Colonies. Later on, lectures took the place of premiums; but the Society has remained unspecialized, though other learned societies arose more or less directly from it.

One of the gold medals of the Society of Arts was awarded in 1794 to Captain William Bligh (1754–1817) for his success in conveying a cargo of six hundred breadfruit plants to the West Indies in H.M.S. *Providence*. The story of Bligh's earlier attempt, which led to the notorious mutiny of the *Bounty*, is well known. Another scientific traveller, who, like Bligh, became a Fellow of the Royal Society, was George Forster (1754–94), the son of J. Reinhold Forster. He and his father accompanied Cook in the *Resolution*, as naturalists.

In the field of chemistry two bicentenaries call for commemoration. Ernst Gottfried Fischer, born at Saalfeld on July 17, 1754, translated C. L. Berthollet's "Recherches sur les Lois de l'Affinité" into German in 1802. To the translation Fischer added some account of the little-known work of his fellow-countryman, J. B. Richter, who had prepared a number of tables showing the weights of acids that combined with different alkalis. Fischer, by re-calculating them to form one comprehensive whole, actually published the first consolidated table of combining weights. This table was reproduced in Berthollet's "Statique Chimique" in 1803, and so became widely known. It illustrated the Law of Reciprocal Proportions, although that name was not adopted until later. Fischer died in Berlin in 1831.

Some years before the publication of Fischer's table, Joseph Louis Proust, born at Angers on September 26, 1754, had recognized, in 1797, the Law of Constant Proportions (Proust's Law). Proust was chemist in the royal laboratory at Madrid during 1789–1808. Gifted with remarkable analytical skill, he always based his results on careful analyses, and over a period of nearly ten years he opposed the view of the influential Berthollet that substances combined in varying proportions, until eventually chemists accepted Proust's conclusions. In 1808 the French army entered Madrid and Proust's laboratory was totally destroyed. Proust retired to Mayenne, and died in 1826, while on a visit to his native Angers.

The seventeen-eighties were the years of the first balloon ascents. Proust himself was probably the first chemist to make an ascent, for he accompanied the intrepid Pilâtre de Rozier on a flight in a Montgolfier balloon in 1784, watched by Louis XVI and the King of Sweden. De Rozier had made the first human ascent in 1783, in a hot-air balloon, and two years later, in June 1785, he was killed, with a companion, when the balloon in which they were endeavouring to cross from France to England exploded. This was the first recorded aerial fatality. An outstanding figure of this period was the French soldier scientist, J. B. M. Meusnier, who in December 1783 submitted to the Academy of Sciences a memoir on aerostatic machines. Meusnier, born at Tours on June 19, 1754, was at this time a lieutenant in the Corps of Engineers. He was already known for his work in mathematics, and in 1784 he produced drawings for an ellipsoidal balloon to be driven by three hand-operated airscrews. The vessel was never constructed, but Meusnier appears to have had a remarkable appreciation of aerostatic problems. Unfortunately, when only thirty-eight but already a general in the French army, he was killed in the fighting before Mayence, on June 17, 1793.

Another inventive genius of this period was William Murdock, born at Old Cumnock, Ayrshire, on August 21, 1754. In 1777 he was engaged by Matthew Boulton, after an interview at the famous Soho Manufactory in Birmingham, and the following year he was sent to Cornwall to supervise the erection of pumping engines. It was while at Redruth that Murdock began his famous experiments on gas-lighting. Here, too, he built a small three-wheeled steam carriage. When this fiery vehicle, which had outdistanced its inventor, was encountered late at night by a local clergyman, it was mistaken for 'Old Nick' in person! Murdock has many inventions to his credit, and his use of compressed air to ring the bells in his house was copied by Sir Walter Scott at Abbotsford. Murdock was awarded the Rumford Medal of the Royal Society for his work on the use of gas for lighting. He died in 1839, and was buried at Handsworth Church, near the graves of Boulton and James Watt.

Of the centenaries to be celebrated in 1954, it seems probable that the one most likely to receive international attention will be that of the death of

Georg Simon Ohm. The Bavarian physicist, born at Erlangen in 1789, was the son of a locksmith. His early years were full of struggles and disappointments. His great discovery, establishing a quantitative relation between electric current and electromotive force in the same conductor, was published in Berlin in 1827 in a pamphlet with the title "Die galvanische Kette matematisch bearbeitet", and was based on experiments carried out during ten years spent teaching mathematics at the Jesuit High School at Cologne. It seems almost unbelievable that work of such importance should have been met with indifference and even been described as "a web of naked fancies"; but such is the case. Recognition came at length from outside his own country, with the award, fourteen years later, of the Copley Medal of the Royal Society. It was not until 1852 that his merit was fully acknowledged in Germany, when he was appointed professor of experimental physics at Munich. He died on July 7, 1854. In 1881 the International Congress on Electric Units in Paris honoured his memory by naming the practical unit of resistance the 'ohm'.

Another physicist of note was the Italian, Macedonio Melloni (born 1798), who died of cholera on August 11, 1854. By developing the thermopile, invented by Leopoldo Nobili in 1829, he was able to make an exhaustive study of the properties of radiant heat. He received the Rumford Medal of the Royal Society in 1834 and became a foreign member in 1839.

Two veteran scientists who also died in 1854 were Arthur Aikin and Robert Jameson. Aikin, born at Warrington in 1773, was a chemist and mineralogist. As a boy he learnt chemistry from Priestley. A founder of the Geological Society, from 1817 until 1839 he was secretary of the Society of Arts, and in 1843 became president of the Chemical Society. Robert Jameson, born in Leith in 1774, intended to adopt medicine as a profession, but his enthusiasm for natural history soon led him away from the surgery. In 1800 he published a "Mineralogy of the Scottish Isles", based on his visits to the Shetlands, Orkneys and Hebrides. In the same year he went to Freiberg to study under the celebrated Werner, with whose doctrines his name was to become closely associated. On his return to Scotland in 1804, he was appointed professor of natural history in the University of Edinburgh, and occupied that chair for fifty years. At the time of his appointment the museum collection was extremely small, and Jameson devoted himself to obtaining specimens for it, by gift and by purchase. During his long life he built up a collection of which Edinburgh, and indeed Scotland, could be proud, and the Royal Scottish Museum is his best memorial. Although generally thought of as a geologist and mineralogist, Jameson was joint editor with David Brewster of the *Edinburgh Philosophical Journal*, and edited an edition of Wilson's "American Ornithology". When Audubon visited Edinburgh in 1826 he met Jameson, and remarked that beneath a rough exterior "he owns a generous heart, which is not at first discernible".

Jameson had many students who became famous, and when his death, on April 19, 1854, left the chair of natural history vacant, it was one of the most brilliant of these, Edward Forbes, who was appointed to fill it. But brilliance, overwork and ill-health often go hand in hand, and only a few weeks after the winter session began Forbes died—on November 18—and was laid to rest in the Dean Cemetery. He was then only thirty-nine, having been born in the Isle of Man in 1815. As a school-boy he was devoted to natural history, and as a medical student in Edinburgh, during 1831–35, he followed his bent to the full. Like Jameson, he soon gave up thoughts of a medical career. After Edinburgh he studied in Paris and, as well as travelling in Europe, visited Algiers. His main interest lay in the realm of marine zoology; but those were the days when it was possible to cultivate several fields, and in 1842 he was appointed professor of botany at King's College, London, and two years later he became, as well, palæontologist to the Geological Survey. When the School of Mines was opened in 1851 he was the first professor in natural history. Some of his best work was done as naturalist to H.M.S. *Beacon* in 1841, the results of which he reported to the British Association in 1843. In this connexion his classification of 'zones of life' in the sea entitles him to be regarded as one of the founders of oceanography.

Others who died in 1854 were Charles François Brisseau-Mirbel (born 1776), the French botanist who was a pioneer in microscopic vegetable anatomy and physiology, and George Newport, a distinguished English amateur entomologist. Newport (1803–54) was the son of a wheelwright and as a youth was apprenticed to the trade, but was later enabled to study and qualified as a medical practitioner in 1835. He was elected a Fellow of the Royal Society in 1846, and received a Royal Medal from the Society in 1851.

When we survey the group of scientists who were born in 1854, we have reached the age of the specialist. Yet Henri Poincaré stands out as an exception, and has been described as "the last universalist" in the field of mathematics. Born at Nancy on April 29, he was sixteen when the Franco–Prussian War brought him into close contact with the rigours of invasion. In 1881 he became professor of physical and experimental mechanics at the Sorbonne, and afterwards occupied in turn the chair of mathematical physics and that of mathematical astronomy. Had there been a chair in the philosophy of science, it would surely have been his too. He died in 1912, and in a span of thirty-four years work he produced nearly five hundred mathematical papers and more than thirty books on mathematical astronomy and physics. He had a gift for clear exposition, and his works on the philosophy of science became extremely popular and were translated into several languages. He even achieved that rare honour for a French scientific writer, membership of the literary section of the Institut de France. President of the Paris Academy of Sciences at the age of fifty-two, and the recipient of honours from all the leading scientific societies, his sudden death came while he was still at the height of his powers.

Two physicists who laboured in more restricted fields were Janne Rydberg and Julius Elster. Rydberg, born at Halmstad on November 8, 1854, was professor of physics at Lund, where he died in 1919. His memoir "Recherches sur la Constitution des Spectres d'Emission des Elements Chimiques", published in 1890, became a classic in the field of spectroscopy, and the 'Rydberg constant' has played an important part in the development of atomic theory. Elster (1854–1920), a German physicist, carried out with his fellow-countryman, Geitel, important researches on the conductivity of the atmosphere. They also produced the first workable photoelectric cell.

The fame of H. W. Bakhuis Roozeboom, a Dutch physical chemist, born on October 24, 1854, rests

chiefly on his practical application of Willard Gibbs's phase rule. Although Gibbs's work was published in 1876, it remained practically unnoticed until Roozeboom took it up in 1884. He became professor of chemistry at Amsterdam in 1896, and died in 1907.

In the field of organic chemistry, we have Paul Sabatier, born at Carcassone on November 5, 1854, who devoted his life to research into the problems of catalysis. He was the first to pay detailed attention to the advantage of using small quantities of certain oxides with a nickel catalyst. Famous as the co-discover of the process of the catalytic hydrogenation of oils to solid fats, the process to which we owe margarine, in 1912 he shared with Grignard the Nobel Prize for Chemistry. He was a foreign member of the Royal Society, and died at Vichy in 1941.

Two German bacteriologists whose names are almost household words were born in 1854. Emil von Behring was one of the pioneers of serum therapy, and introduced the term 'antitoxin'. His discovery of diphtheria antitoxin led to an amazing decline in the mortality figures for diphtheria. In 1901 he received the first Nobel Prize for Medicine. He was professor of hygiene in the University of Marburg from 1895 until shortly before his death in 1917. Paul Ehrlich, born in Silesia of Jewish parents, created the science of chemotherapy. He was director of the Royal Institute for Experimental Therapeutics at Frankfurt-am-Main. It was his discovery of salvarsan or '606' which made his name famous, and in 1908 he was joint recipient with Metchnikoff of the Nobel Prize for Medicine. He died in 1915.

The problem of the breeding habits of eels has attracted naturalists since the days of Aristotle. Much of the credit for its solution goes to the Italian zoologist Giovanni Battista Grassi (1854–1925), who discovered that members of the so-called genus *Leptocephalus* were in reality adolescent eels. It was this clue which enabled Johannes Schmidt, the Danish biologist, to track the European eel to its breeding ground south-east of Bermuda. Grassi is also famous for his researches in the fields of helminthology and entomology, and in particular for his work on the transmission of malaria. He died in Rome, where he was professor of comparative anatomy, in 1925.

The impact of biology on everyday life inevitably provides the biologist with a wider public than that of the specialist in one of the mathematical sciences. But when the latter finds practical application for his discoveries, a different situation may arise. When Sir Charles Algernon Parsons died in 1931, Sir Richard Glazebrook, in an obituary notice (*Nature*, **127**, 315; 1931) described him as "one of the world's greatest benefactors". Charles Parsons was the youngest son of the third Earl of Rosse (himself famous as the constructor of a large reflecting telescope), and after studying mathematics at Cambridge went to the Armstrong Works as apprentice. It was as a partner in the firm of Clarke, Chapman and Co. at Gateshead that he built his first turbine, an invention that was to revolutionize power production. He carried out many other scientific and mechanical investigations, and did much to raise the status of the British optical glass industry. He received many honours, including the Copley and Rumford Medals of the Royal Society, and the Order of Merit in 1927. His death while on a cruise in the West Indies in 1931 was a severe loss to British science.

Another inventor, Ottmar Mergenthaler (1854–99), a German by birth who became an American citizen, is remembered in connexion with his linotype machine, which was adopted first by the Press of the New World and then that of the Old.

Other scientists born in 1854 include the palæobotanist D. H. Scott, Sir Patrick Geddes, biologist and pioneer in town and regional planning, Sir William Napier Shaw, the meteorologist, and Sir James Frazer, the eminent author of "The Golden Bough".

In conclusion, let us recall that three hundred years have passed since Otto von Guericke, inventor of the air-pump, demonstrated before the Emperor Ferdinand III at Regensburg the experiment of the 'Magdeburg hemispheres', when two heavy teams of horses, urged on by their drivers, completely failed to separate Guericke's copper hemispheres fitted together as a globe and evacuated by the air-pump—surely one of the most spectacular demonstrations of a vacuum ever staged!

THE ROYAL SOCIETY OF ARTS

ON November 18, with its president, the Duke of Edinburgh, in the chair, and the Earl of Radnor, chairman of its Council, beside him, the Royal Society of Arts opened its two hundredth session of meetings. As was appropriate with the approach of a bicentenary, a variety of circumstances emphasized the antiquity of the Society and helped to span the centuries: the fine Adam room where the Society has held its meetings since 1774; the clock which for even longer has marked the hour for their commencement; and the very day of the week, Wednesday, on which it has regularly met since the year of its foundation. But the strongest links of all (since a society, like a city, consists of men, not walls) were to be found in the two principal personages themselves, for the President referred to the continuous association of the Royal Family with the Society for well over a century, and the Chairman of Council took as the subject of his address the first President, Viscount Folkestone, whose lineal descendant he is.

But it was equally apparent that, with an institution at any rate, age need not bring any diminution of vigour. Symbolically, it seemed, the ancient lecture hall was ablaze with the floodlights needed for the making of a film; and the occupant of the chair was a young man whose special word of praise for the body over which he had come to preside was that it was forward-looking and not concerned overmuch with its illustrious past.

To be forward-looking, indeed, is not so much a desirable characteristic of the Society of Arts as its very *raison d'être*. According to its full title it is "The Society for the Encouragement of Arts, Manufactures and Commerce", and 'encouragement' meant to its founder, William Shipley, no mere avuncular patronage, but active stimulation to progress. "Encouragement", he wrote in his original plan for the Society, "is much the same to arts and sciences as culture is to vegetables: they always advance and flourish in proportion to the rewards they acquire and the honours they obtain." The object of the Society, then, was to lead the way towards progress and prosperity, progress of the kind which was clearly defined the other day by its new President. "The Society of Arts is not concerned", said His Royal

Highness, "with just doing things in a different way, which some people call progress, but with doing practical things in a better way, which is real progress." That is precisely what Shipley wanted his Society to aim at—getting people "to do practical things in a better way".

But before the Society could assist such progress it had to convince people that it was needed. The mental atmosphere of the time is well indicated in the letter which Benjamin Franklin wrote to the Society in 1755 when accepting its Corresponding Membership. "Never be discouraged", he said, "by the Apprehension that Arts are come to such Perfection in England as to be incapable of further Improvement. As yet, the Quantity of Human Knowledge bears no proportion to the Quantity of Human Ignorance." In a day when such a warning was needed the method of "encouragement" which Shipley advocated could not have been bettered. It lay, as Shipley said, in the offer of "rewards" and "honours", and at the very first meeting of the Society, held on March 22, 1754, Shipley persuaded the little group of eleven foundation members to launch out at once with the offer of four prizes, two for simple technical purposes and two for children's drawings, because of the practical importance of the art of drawing in industry. There was sufficient response to this first simple effort to justify its repetition and extension, and in a few years the newspapers began to carry long lists of awards offered for the improvement of literally hundreds of practical objects and processes. Some of these offers bore immediate fruit in the successful achievement of the objects for which the prizes were put up. But the chief benefit lay in their broad psychological effect, for they taught people to realize that improvement was possible in many things which they had hitherto considered to be as perfect and fixed as Plato's "ideas".

One of the most impressive results of this educative work of the Society was the introduction of the 'new husbandry', the supercession of broadcast sowing by the seed drill used in conjunction with the hoe. Regarding this fundamental change in agriculture, Robert Dossie said in 1768: "The practice was very little pursued until the Society awakened public attention to it by their premiums". Many other important results were achieved in the same way: the development of agricultural and industrial machinery (for example, Dossie said that until the Society offered a prize for the design of a machine for slicing turnips no one had ever thought of doing it otherwise than by hand), the introduction of new crops, the establishment of new chemical and textile industries, the improvement of road-vehicles, and countless other practical objects of greater or less importance. In addition, its numerous annual offers of prizes for various kinds and degrees of artistic accomplishment gave a most valuable encouragement to thousands of young artists, many of whom afterwards rose to eminence.

Not only was the Society's premium system applied to a vastly differing range of objects but it was used to good effect overseas, just as there is now a special Commonwealth Section of its lecture programme. One of the more spectacular results of its offers on behalf of the Colonies was the expedition of the *Bounty*, the origin of which was closely connected with the prize which the Society began to offer in 1777 for the transplantation of the breadfruit tree from the East to the West Indies, and which was ultimately awarded to Bligh in 1793.

Nowadays the Society's competitions are confined normally to the award of travelling bursaries to students of industrial design and to various objects in connexion with navigation, and with education for the Merchant Service, under the Thomas Gray Memorial Trust; but in its endeavours to stimulate and encourage progress the Society soon found the value of exhibitions, and, as was demonstrated in its Exhibition of Exhibitions in 1951, it has been a pioneer in the exploitation of this form of publicity. The first British exhibition of contemporary art (which ultimately led to the foundation of the Royal Academy), the first exhibition of agricultural and industrial machinery, and above all the first international exhibition—all these (and many similar pioneer efforts) must be credited to the Society of Arts; and of the Great Exhibition (whatever its faults) the immense stimulating effect can scarcely be over-estimated. In more recent times the Exhibition of British Art in Industry, organized by the Society in co-operation with the Royal Academy, showed what widespread results a comparatively small exhibition can achieve when devoted to the right theme at the right time.

So essentially was the Society of Arts founded for "encouragement" rather than mere instruction that it was at one time often criticized for its weakness in straightforward propaganda. During its early years it was so busy stimulating others into activity that it had little time to concern itself with the regular publication of its own proceedings, and it was only after thirty years that it realized that much of the benefit of the successful activity which it had stirred up by its prizes was being lost because those who did not compete were not being informed of the results. In 1783, therefore, it began to publish an annual volume of *Transactions*, in which the experiences of prizewinners were recounted for the benefit of others, but even this series more or less lapsed after fifty years. Since 1852, however, it has more than made up for its early deficiencies by publishing a weekly Journal without a single break for nearly ninety years, followed by its present practice of fortnightly publication. This is a record unapproached by more than one or two other learned societies in Great Britain, and as during the past hundred years the primary activity has been the reading and discussion of papers on as wide a variety of practical subjects as originally formed the basis of its prize competitions, there has been no lack of suitable material.

One other well-known and important effort of encouragement on the part of the Society remains to be mentioned—its system of commercial examinations. One effect of the great fillip which the Great Exhibition gave to adult education was the spread of 'mechanics' institutes', and in these the Society took a most active interest, organizing them into a union, assisting them to obtain lecturers and books, and generally acting as a clearing-house for useful hints by which they could help one another to render more effective service to their members. It soon became apparent, however, that the working classes needed something more solid than quantities of popular lectures and other forms of 'uplift'. They needed to get down to concentrated study, and it was as a guide and stimulus to such effort on the part of members of mechanics' institutes in various parts of the country that the Society held its first annual examinations at local centres in 1856—two years before the first Oxford and Cambridge 'locals'.

Nearly twenty years later the Society hastened to support the steps which were being taken to institute systematic technological training by introducing a system of technological examinations. After a few years, however, these, as is well known, were entrusted to the newly founded City and Guilds of London Institute, while the Society itself concentrated on education for commerce and began to develop a system of local examinations in commercial subjects which has always been the largest of its kind in Britain and has far-reaching effects in maintaining a standard of knowledge and attainment in this field.

Such, then, are some of the ways in which the Society has endeavoured to be "forward-looking". Shortly, however, the completion of another secular period will be compelling it for a short time to look back. A variety of bicentenary celebrations have been planned. The first event on the actual anniversary, Monday, March 22, 1954, will be a service of thanksgiving at St. Martin-in-the-Fields, when the sermon will be preached by the Bishop of Peterborough, one of whose predecessors in office was a very early member of the Society. This will be followed later in the day by a ceremony at which the congratulations of certain kindred societies, representing the great number of bodies now concerned with the subjects which fall within the Society's wide field, will be presented to the Chairman of Council. On the Tuesday, Wednesday and Thursday of that week a series of three special lectures will be delivered, reviewing broadly the developments which have taken place in the three fields—"Arts, Manufactures and Commerce"—which provide the basis of the Society's title. These subjects will be dealt with by Prof. Nikolaus Pevsner, Sir Ben Lockspeiser and Sir Geoffrey Heyworth, respectively. The week's engagements will close with a banquet on the Friday evening at the Savoy Hotel; but the climax of the celebrations will not be reached until later in the year, when an evening reception is to be held on June 29 at St. James's Palace.

Apart from these social and ceremonial activities, a number of other steps are being taken by the Society to mark the occasion. A badge of office is being provided for the first time for the chairman of Council and will form a permanent memento, while the annual award of a bicentenary medal, which is being initiated to recognize distinguished services to industrial design (other than those of designers themselves), will also, by its name, provide a permanent commemoration. A new full-length "History of the Society" has also been prepared and will be published in the spring.

Lastly, somewhat skittishly, as befits a period of celebrations, but with a serious purpose as well, the Council has organized a competition in which speculations are invited on the practical aspects of life on the earth in the year 2000. Some details of this competition (which is open to all) were published in *Nature* on November 28 and full information may, of course, be obtained from the Society. The emphasis is to be placed on originality, and while no doubt many of the entries will provide amusement, it is the Council's hope that some of them may display those flashes of inspiration which can lead to valuable new lines of thought and invention. Certainly the competition should provide some interesting retrospective material for those responsible for organizing the fifth jubilee of the Society, in 2004!

Kenneth W. Luckhurst

THE SCIENCE OF PHARMACOLOGY*

By Prof. J. H. Gaddum, F.R.S.

THE science of pharmacology was started at about the beginning of this century in order to apply physiological results and physiological techniques to the reform of therapeutics. In more recent years, we have come to realize that the science of pharmacology also uses techniques which we share with biochemistry, microbiology, pathology and even mathematics. The applications of pharmacology include not only human therapeutics but also veterinary therapeutics, toxicology, pest control and chemical warfare (which, as Sir Henry Dale has pointed out, may be regarded as a special kind of pest control). Our results may be applied not only to cure but also to kill, and not only to man but also to other animals.

During the past fifty years, there has been a revolution in medicine, and the most important part of this revolution has been the rise of therapeutics. Fifty years ago, medical men were interested in diagnosis and in post-mortems; but when they were honest with themselves, they realized that there was very little they could do to cure their patients. The position is very different to-day, when it may be said that therapeutics is the most important part of medicine.

The first task of the young science of pharmacology was to purge the pharmacopœia by casting out useless drugs. Hundreds of drugs were removed from the pharmacopœia because no one knew how they acted. It would be surprising if we did not lose some valuable drugs in the process.

The second task of pharmacology was to discover new remedies. Those of us who are responsible for teaching medical students sometimes feel that our science has been almost too successful in this direction. The burden on the students diminished when the pharmacopœia was purged, but it is now increasing again. This new knowledge has been acquired mainly by the process of trial and error. Simple screening tests are devised and used in a more-or-less blind search for active drugs. This process has led to the most spectacular contributions of our science to practical medicine. The actual work is, however, essentially dull—or perhaps I should say it is not the kind of work that attracts the academic type of mind; and it is not the kind of work that is easily done in academic laboratories. The academic pharmacologist is in an exceptionally strong position to know what drugs are required and to devise screening tests for them. Pharmacologists who work for the great commercial firms have also been responsible for some of the screening tests in use, and these firms have been mainly responsible for turning good ideas into practical achievements. This can only be done by organizing research on a large scale.

The great value of organized projects was triumphantly demonstrated during the Second World War, and some people think that more organization now is desirable; but those who are so organized are less likely to make unexpected discoveries than those who indulge in random research. An organized project is like mechanical transportation; it provides a quick way of reaching a foreseen objective, but it does not provide a good method of exploring the country.

* Substance of an address at the Fall Meeting of the American Society for Pharmacology and Experimental Therapeutics, 1953.

A botanist who studied the flora of a railroad embankment from a train would no doubt get his work done quickly; but he would not be likely to discover any new species of plant.

Pharmacology has, of course, many other tasks. There is much to be done in the study of the absorption, metabolism and excretion of drugs. This branch of pharmacology is particularly dependent on contact with biochemistry, since it uses biochemical techniques.

There is a great deal to be done, too, in connexion with the toxic effects on man of the substances used for killing insects, and of the substances used to 'improve' foods. The drugs used in therapeutics undoubtedly also have many toxic effects still to be discovered. The methods available for detecting such toxic effects are not very satisfactory. It is particularly important that someone should improve the methods available for proving that drugs will not have toxic effects when given over long periods.

Another task for pharmacologists is to collaborate n the clinical trial of new remedies. During the past few years, there has been much advance in this field. Most people now realize the importance of careful design in therapeutic experiments and of the need for controls. Well-designed experiments have been carried out on diuretics, on the drugs used in the treatment of tuberculosis, common colds, motion sickness and headaches, and of many other such conditions. The techniques used are essentially similar to those used in bioassay, and it is good to see that pharmacologists are taking an active part in this work.

Pharmacology, however, is not only the handmaid of therapeutics; it is a science in its own right, and has many other tasks to perform. The most important one is to find out how drugs act. This probably involves finding out how living tissues act. Pharmacologists have contributed much to this. At the recent international meeting of pharmacologists in Montreal there was a discussion about autonomic ganglia, and a discussion about renal transport mechanisms. In both these fields pharmacologists have contributed much to physiology.

Many pharmacologists also use biochemical techniques, but it would be a mistake to suppose that pharmacology will ever become entirely dependent on biochemical techniques. Some biochemists have become successful pharmacologists, but the transformation cannot take place very rapidly; it is often more satisfactory when a man who starts as a pharmacologist acquires biochemical techniques in order to solve pharmacological problems. Pharmacology also depends on the techniques which are used in microbiology for the study of bacteria and protozoa; these play an important part in that branch of pharmacology which is called chemotherapy. A pharmacologist must also be prepared to use the techniques of pathology and statistics when his problems require it.

Pharmacologists have contacts with many other sciences. They can develop in many different directions and are particularly well placed for getting new ideas. Some of their new ideas have a very stimulating effect on allied sciences. The physiological importance of acetylcholine, of the enzymes which destroy it, and the drugs which inhibit these enzymes were discovered by pharmacologists, but have provided a stimulus for the biochemists. The sulphonamides were a pharmacological discovery, but they have provided work for the bacteriologists.

The main contribution of pharmacology to fundamental knowledge has come from the development of the techniques of bioassay. The application of such techniques to the estimation of hormones in blood and urine is playing an important part in clinical endocrinology, and pharmacologists have much to do in this field. That branch of knowledge which is called autopharmacology has, however, yielded more important results. All our knowledge of the physiology of histamine, acetylcholine, epinephrine and *nor*epinephrine depends upon bioassay. The methods used are founded upon the work of Dr. J. J. Abel, Dr. Otto Loewi, and Sir Henry Dale, and this branch of knowledge is still growing. Some people do not realize how precise some of these methods are. In recent years it has been found that propionylcholine is present in animal tissues as well as acetylcholine. It is a comfort to reflect that the pharmacological methods which were used twenty years ago to study the substances released in the superior cervical ganglion of a cat and in some other tissues were specific enough to distinguish between these two esters. We can, therefore, rest assured that the main substance released in this ganglion is not propionylcholine; there is still no reason for doubting that it is acetylcholine.

Eventually these pharmacological methods will be replaced by chemical methods; but I hope that this process will not take place too quickly, since new pharmacologically active substances are still being discovered in the study of methods of estimating the old ones. When we have chemical methods, this process will be inhibited.

OBITUARIES

The Right Rev. E. W. Barnes, F.R.S.

Bishop Barnes was born on April 1, 1874, in Birmingham and died on November 29, 1953, in Hurstpierpoint. Educated at King Edward VI High School, Birmingham, he entered Trinity College, Cambridge, as a mathematical scholar and graduated as second wrangler in 1896. He was placed in Division 1, Class 1 of Part II of the Mathematical Tripos in 1897 and was awarded the First Smith's Prize in 1898. In the same year he was elected a Fellow of Trinity College, where in due course he became junior dean, lecturer and tutor. As a lecturer he was clear and concise; as a tutor, though somewhat aloof and regarded as rather unapproachable, he was a wise and careful guide. He developed a rich humanity later, particularly after his marriage in 1916 to the daughter of Sir Adolphus Ward, Master of Peterhouse. He was elected a Fellow of the Royal Society for his researches in pure mathematics. His chief contributions were fundamental studies on the hypergeometric function and on gamma-functions, but he also wrote valuable papers on Legendre and Bessel functions. At the dinner of Section A (Mathematics and Physics) of the British Association during the Birmingham meeting in 1950, he made a happy speech, giving his recollections of his life in Cambridge and of his relations with mathematicians ranging from Cayley to Eddington.

He was ordained in 1902 and soon became widely known as a thoughtful, outspoken preacher. In 1915 he was nominated by Asquith as Master of the Temple, and despite his unpopular pacifist views he was chosen in 1918 by Lloyd George as a Canon of

Westminster; in 1924 he was selected by Ramsay MacDonald for the vacant bishopric of Birmingham, where he remained until his retirement on account of ill-health in 1952. From 1924 onwards he became more and more involved in controversies in the Church, fighting on behalf of truth as he saw it and as he fearlessly proclaimed it. His views are expressed in "Should such a Faith Offend ?" (1927), a series of addresses to such bodies as the British Association, the British Medical Association, the International Congress of Psychology and the Eugenics Education Society. The fact that he was invited by such bodies to address them indicates their appreciation of his position in the world of religious intellect and of his efforts to awaken the Churches to the need of facing up to the findings of modern science. His Gifford Lectures on "Scientific Theory and Religion" given in the University of Aberdeen (1927–29) develop this important side of his teaching; his later books, "The Rise of Christianity" (1947) and the Rede Lecture to the University of Cambridge (1949), "Religion amid Turmoil", involved him in serious disputes inside the Anglican community.

This is not the place to discuss the theological controversies in which Bishop Barnes took an active part, nor the position of the Broad Church party within the Anglican Church; but tribute must be paid to the complete honesty and love of truth which he displayed in his battle against much that he regarded as superstition. For him, truth was to be sought and followed even though some traditional dogmas of Christian belief had to be changed. He could and did state that science had preserved standards which organized religion had frequently failed to safeguard. Despite protests, he felt it his duty to proclaim this from inside the Church; his mission was to attempt to free Christianity from many late accretions.

In his intellectual approach to such questions, in his views that religion is essentially fellowship with the unseen and that the spiritual world is a type of reality lying outside the world of sense, Bishop Barnes must have found many outside the churches who were in close agreement with him. How far his deeply religious sense could bridge the gap between those outside and those within the churches it is not easy to say. But there is little doubt that any body which condemns men of his honesty and width of outlook is running a serious risk of alienating more and more serious thinkers from its fold.

Barnes was deeply concerned with the need to adapt Christian theology to meet the changed viewpoint resulting from the acceptance of evolution. He was at odds with both fundamentalism and sacramentalism for their failure to win the confidence of educated youth. The modern world demands that faith should be reasonable and not blind. Faith he defined not as submission to authority but as the product of our best, expressing itself in our relations with all our fellow men in all our human activities, not merely in those which we call religious. For Barnes, Christianity must be dynamic and not static; though it is the finest product of the religious evolution of the race, there must be freedom in it for further onward movement. As the conscience of man gradually develops in humanity, so must a factor of variability be allowed in the statements of our faith.

Barnes emphasized in his book "The Rise of Christianity" that the use of scientific methods in the examination of documents and early records, even when applied in the most radical way, did not affect what he regarded as the fundamentals of Christianity. The progress of knowledge has not forced us to admit imperfection in the view of God and of man's relation to God as given by Jesus, but it should compel some changes in the framework in which those views are expressed. In forming our attitudes to moral issues and to social problems which have arisen in the complex society of to-day, we must look to fundamental principles and not to set teaching of the past. The unity between the human mind and the processes of Nature is paralleled by a unity between the moral and æsthetic judgments of the human spirit and the Divine Spirit.

Barnes issued a double appeal—to the men of religion to adopt the outlook of science with its reverence for truth, and to the men of science to foster spiritual progress while preserving spiritual freedom.

F. J. M. Stratton

Prof. C. Białobrzeski

Like so many other prominent Polish intellectuals, Białobrzeski (pronounced Biauobjesky) was a descendant of the class of small gentry of the eastern borderland. Having finished his studies at the University of Kiev, he went to Paris and investigated in P. Langevin's laboratory the influence of radioactive radiations on solid and fluid dielectrics. Returning to Kiev, Białobrzeski graduated in physics and afterwards lectured in physics and mathematics. In 1914 he was invited to Cracov, where he was installed at the Jagellonian University as professor of theoretical physics, at the end of the First World War.

Meanwhile, Białobrzeski published in 1913 in the *Bulletin of the Academy of Science* of Cracov his main work, a paper on the equilibria of stars. It was customary up to that time to treat this problem as one of a sphere of gas in polytropic conditions. Białobrzeski introduced the pressure of radiation as a new factor. Owing probably to the outbreak of war in 1914, this paper remained little known, so that his results were, a few years later, rediscovered by Eddington. In 1920 Białobrzeski moved to the University of Warsaw, where he held the same chair, and created a flourishing school of research in theoretical physics. As he always believed in the co-operation of theory and experiment, he organized also, in his institute, a laboratory for the study particularly of spectra and dielectrics. He himself contributed in 1927 a further astrophysical paper discussing the role of fluctuations. Very early he became interested in the new quantum-mechanics and gave it a large part in his lectures.

This 'idealistic bias' brought Białobrzeski a lot of trouble in his last years. An idealist he was indeed, in the less technical, true, meaning of the word. He believed, as he showed in his popular writings, that the mission of science was to promote the moral progress of mankind. A marked aloofness and far from robust health did not prevent him contributing to the academic underground teaching during the German occupation. In the early months of the War, the Germans publicized the shooting of a namesake of Prof. Białobrzeski; and an obituary notice by Dr. M. Mathisson was then published in *Nature* (145, 132; 1940). The present notice is intended to be complementary to the former. During the relatively liberal spell, in 1947, he visited Great Britain. He died during September last at the age of seventy-five.

Z. Klemensiewicz

NEWS and VIEWS

University of the Witwatersrand: Dr. Humphrey R. Raikes

Dr. Humphrey Rivaz Raikes, vice-chancellor and principal of the University of the Witwatersrand, is to retire; he was appointed principal in 1928 and vice-chancellor in 1948. Dr. Raikes received his early education at Tonbridge School and Dulwich College, and went up to Oxford in 1910. After serving in the First World War, he was elected a Fellow of Exeter College in 1919, a position which he held until he went to the University of the Witwatersrand. In the quarter of a century since his arrival, the annual student enrolment of the University has more than tripled—from 1,362 in 1927 to 4,272 in 1953, which is but a slight recession from its post-war crest of 5,240 in 1946; the professorial staff has increased from 36 to 53, and the academic and administrative staff has quadrupled, from about 180 to more than 720. Typical of the contribution made by the University's graduates to the social life of the South African community is the fact that its medical graduates, the first of whom graduated in 1924, to-day number 2,038 and constitute a third of the practitioners on the Union register of medical practitioners. Concurrently, its faculties of arts and science, engineering and architecture, commerce, law and dentistry have made correspondingly impressive impacts upon the communities of South Africa in particular, and of the African continent generally, especially during and after the First and Second World Wars. A token of the Institution's expanding needs is the launching of its £1,000,000 appeal for funds, which was one of Dr. Raikes's latest activities. Emblematic of the variety and service characterizing the institution's progress under his leadership are the establishment of the Bernard Price Institute of Geophysical Research, the Bernard Price Institute for Palæontological Research, the University Speech Voice and Hearing Clinic, the University Field Botanical Research Station at Frankenwald, the Oral and Dental Hospital, the Alexandra Township Health Centre and the James Grey Community Centre. It is indicative of the international recognition extended to this progress and leadership that honorary degrees have been conferred on Dr. Raikes by the Universities of Cape Town, Bristol, Toronto and Cambridge.

Prof. W. G. Sutton

Prof. William Godfrey Sutton, head of the Department of Civil Engineering, University of the Witwatersrand, has been appointed principal of the University in succession to Dr. Humphrey R. Raikes. Prof. Sutton was educated at King Edward VII School, Johannesburg, South African College and the University of Cape Town, becoming lecturer in applied mathematics at the South African College in 1914. After serving in the First World War in German East Africa, he took the B.Sc.(Eng.) with distinction in 1918, and joined the Irrigation Department of the Union of South Africa as assistant engineer. He was seconded to the United States Reclamation Service to gain practical experience (1921–22), and appointed to the chair of civil engineering at Johannesburg in 1926. During the Second World War he served first as general manager of the Central Organization of Technical Training in the Department of Defence, later as chief technical adviser in the Department of Commerce and Industries, and finally as chairman of the Advisory Committee to the Government on post-war development in the engineering and chemical industries of South Africa. He had visited Germany in 1937 as a member of the British delegation to study the Reichautobahnen, and in 1946 represented the S.A. Standards Institution at the Commonwealth Standards Conference and the conference of the International Organization for Standardization. Prof. Sutton has been president of the S.A. Institution of Engineers (1936–37), of Section A of the S.A. Association for the Advancement of Science (1941), of the S.A. Society of Civil Engineers in 1945, and of the Associated Scientific and Technical Societies of South Africa (1951). He served as chairman of the S.A. Standards Institution (1946–50), as a member of the Council of the Institution of Civil Engineers (Great Britain) during 1950–52, and is at present a member of the S.A. Natural Resources Development Council and of the Council of the S.A. Bureau of Standards.

Paris Academy of Sciences: Elections

The following elections have recently been made in the Paris Academy of Sciences: Prof. K. M. G. Siegbahn, director of the Nobel Institute for Physics, Stockholm, to be a foreign associate of the Academy in succession to the late Prof. S. Winogradsky; Prof. Francis Perrin, professor of atomic and molecular physics in the Collège de France and high commissioner of the French Atomic Energy Commissariat, to be a member of the Physics Section of the Academy in succession to the late Prof. J. Becquerel; Prof. H. J. Backer, professor of organic chemistry in the University of Groningen, to be a *correspondant* in the Chemistry Section of the Academy in succession to Prof. Paul Karrer, recently elected a foreign associate; and Prof. J. Andrieux, professor of electrochemistry in the University of Grenoble and director of the École Nationale supérieure d'Électrochimie et d'Électrométallurgie, Grenoble, to be a *correspondant* in the Chemistry Section of the Academy in succession to the late Prof. A. F. Holleman.

Presentation to Dr. Charles Singer

At a luncheon at Fowey on December 19, Dr. Charles Singer, emeritus professor of the history of medicine in the University of London, was presented with two volumes of essays, entitled "Science, Medicine and History: Essays on the Evolution of Scientific Thought and Medical Practice", written in his honour and published by the Oxford University Press. It is an indication of the world-wide appreciation of Dr. Singer as a historian of science and of medicine that nearly one hundred authors from many countries, all authorities in their special fields, have contributed to this work, which runs to twelve hundred pages and includes more than a hundred plates as well as other illustrations. The essays were collected and edited by Dr. E. Ashworth Underwood, director of the Wellcome Historical Medical Museum and Library. In formally presenting Dr. Singer with a specially bound copy of the two volumes of essays in full polished morocco with gilt edges and inscribed "Carolo Singer haec studia gratissime d. d. d. auctores mensis dec. die xix MCMLIII", Sir Zachary Cope, in the unavoidable absence of Sir Arthur MacNalty (formerly chief medical officer of the Ministry of Health), referred to Dr. Singer's outstanding contribution to the history of science, medicine and

technology, and to the unusual, if not unique, circumstance that this large collection of essays was being presented to one who, at the age of seventy-seven, was still actively pursuing a life of vigorous scholarship and was at the very moment busily engaged on the preparation of a five-volume history of technology. Prof. Singer, in replying, and thanking the authors, referred, among other matters, to the valuable collaboration that he had so continuously received from his wife, Mrs. Dorothea Waley Singer, who, with other members of his family, was present at the ceremony. Others present, besides the editor of the work, included some of the contributors, Prof. V. Gordon Childe, Prof. K. J. Franklin and Dr. Douglas McKie (also representing University College, London, where Dr. Singer formerly held the University chair of the history of medicine), and also some of Dr. Singer's friends—Dr. F. A. Freeth, Mr. R. Affleck Greeves and Dr. C. T. Andrews.

Integrity of the U.S. National Bureau of Standards

The successive publication of the report of the committee appointed in the United States on October 16 to evaluate the functions and operations of the U.S. National Bureau of Standards and of the corresponding committee, chosen by the National Academy of Sciences on November 13 to appraise the work of the Bureau in relation to battery additives, appears to have removed the dangerous challenge to the relations between science and government which had developed in the United States. The latter report completely vindicates the Bureau in its findings regarding the worthlessness of the battery additive known as *AD-X2*: the quality of the Bureau's work in this field is reported as excellent and better than at any time in the past. The report of the former committee was also highly favourable to the Bureau and resulted in Dr. D. V. Astin being persuaded to remain permanently at the head of the Bureau. It fully indicates the competence, integrity and loyalty of the professional staff of the Bureau, but makes some ten major recommendations for improving and strengthening the Bureau. These include more space and modern facilities for fundamental work, an additional associate director for research and the appointment of advisory groups from the membership of eight scientific and technical societies. While men of science in Great Britain will be glad to note the way in which professional opinion in the United States has removed a dangerous challenge to the integrity of scientific work, they will appreciate also the immense waste of time that has been involved and the grave risk that was at one time incurred not only of the loss of the services of a distinguished scientific worker but also of the effectiveness of a scientific agency. The episode has its meaning and warning for scientists in Britain also, where there is still insufficient understanding of the nature of scientific work among politicians and Civil servants. The conditions here are unlikely to parallel exactly those in the United States, but the force of Mr. Robert Birley's observation to the British Association at Liverpool last September is well illustrated.

Quaternary Ecological Studies in Ireland

The Queen's University, Belfast, has accepted an offer by the Nuffield Foundation of a sum of £12,000, spread over four years, to establish research in quaternary ecological studies, and it is hoped to establish a scheme of study at the beginning of next session of the University. The rapid disappearance of many areas of bogland in Ulster, especially in view of the proposed utilization of peat for industrial purposes, is a matter of concern to scientists. No complete scientific description of an Irish bog has ever been made, though the work of Dr. K. Jessen, of Copenhagen, and Dr. G. F. Mitchell, of Trinity College, Dublin, has shown the possibilities. The selection for preservation of small areas of virgin bog as Nature reserves for scientific study is only a small part of the work. Studies of the vegetational succession yield important evidence of the history of the Irish flora, through the identification of pollen grains preserved in the peat, and this provides an essential chronological framework for the archæologist and the student of early Irish culture. Human relics and the effects of human interference with the environment can also be investigated in the bog flora, as well as evidence for the development of agriculture and animal husbandry and for the decline of forests. It is important that in some areas land under the bogs was once cultivated and produced cereal crops, and the study of the processes of bog formation will provide a clue to the best methods of reclamation and rehabilitation. The utilization of the actual bog or fen soils is also a matter of economic importance. The research work will be done in close co-operation with the Survey of Ulster Boglands, now being conducted under the Northern Ireland Ministry of Commerce, and will be under the general supervision of the new professor of botany in the University, Prof. J. Heslop Harrison (who has succeeded Prof. James Small, an original sponsor of the studies), supported by the professors of geography and geology, the lecturer in archæology, and other specialists.

Atomic Scientists' Association

The journal of the Atomic Scientists' Association, previously known as the *Atomic Scientists' News*, has been renamed *Atomic Scientists' Journal*, and commencing with the September number (3, No. 1; 1953) appears under the new title and also with a new cover design. In the editorial for this number the purpose and aims of the Association are reaffirmed and suggestions are offered as to how the influence of the Association, frankly admitted not to be strong, may be increased and spread more widely. The main task of the Association is to supply accurate and reliable information on the scientific aspects of atomic energy and to promote informed discussion on the subject so that the new knowledge may be wisely used; it is therefore disappointing that so few atomic scientists take advantage of the medium afforded by the Association and its journal.

At the annual general meeting of the Association, held at the Clarendon Laboratory, Oxford, on June 4, the following officers were elected: *President*, Prof. H. S. W. Massey; *Executive Vice-President*, Prof. J. Rotblat; *General Secretary*, Mr. G. N. Walton; *Treasurer*, Dr. J. H. Tait; and *Editor and Assistant Editor of the Journal*, Drs. P. E. Hodgson and H. R. Allan, respectively. A brief report of the meeting is included in the September number of the *Journal*, with two articles. The first, entitled "Fundamental Particles", by Dr. Hodgson, relates to the international conference on cosmic radiation held during July at Bagnères de Bigorre (see *Nature*, September 12, p. 477). The second article, "Life at Chalk River", by Freda Kinsey, is of more general interest and describes the position and community life surrounding the Chalk River plant of the Atomic Energy of

Canada, Ltd. Deep River, the residential area for employees, is some ten miles from the plant and its position is isolated, 130 miles north-west of Ottawa and 28 miles from Pembroke. The comforts of modern civilization are well provided, but, as Miss Kinsey points out, the comparative geographical remoteness and disadvantages of a closed community engaged exclusively on secret work are factors which, though not by any means of over-riding importance, should be well borne in mind by those contemplating going from Great Britain to work at Chalk River.

Rate of Accretion of Matter by Stars

A VERY comprehensive investigation of the problem of the development of massive stars from less massive ones by the accretion of interstellar matter is given by Prof. W. H. McCrea in a paper entitled "The Rate of Accretion of Matter by Stars" (*Mon. Not. Roy. Astro. Soc.*, **113**, 2; 1953). An elementary quantitative investigation suggests that under normal conditions for stars and interstellar space the theory is very improbable, but this does not imply that the processes envisaged by the accretion theory do not occur in exceptional cases. The accretion of a large amount of their material in recent astronomical times is required by only a minute fraction of all the stars, and in these circumstances the conditions required are not so improbable as they might appear to be. It is shown that massive stars can be produced from less massive ones by the accretion process if the motion of the star is halted by the interstellar matter, and this can take place if the initial speed of the star relative to this interstellar matter is sufficiently low. Recognizing that the occurrences must be rare, it is shown in the paper that all the necessary requirements are to be found in the Galaxy, and in addition, assuming that the phenomena actually occur, the demarcation between the stars affected and those not affected must be quite sharp, owing chiefly to the sensitivity of the effects to the velocity factors. Having accounted for the mass increment, the question arises whether the theory can also account for its production at a rate that ensures its adequately compensating the transmutation of hydrogen in the stars under consideration. An investigation of this subject shows that no difficulty arises in this way. Regarding the applicability of the theory, it is admitted that the heating effect of the radiation from the star upon the neighbouring cloud material appears to be ignored. It is pointed out, however, that this effect is expected at most to enter at some stage when the star has attained a great luminosity, to produce a cut-off effect; otherwise the application in principle of the theory does not seem to encounter any serious obstacle. The main problem now is to endeavour in some way to estimate the actual frequency of occurrence of the processes.

Glacial Eustasy and the Rotation of the Earth

A PAPER by Andrew Young, entitled "Glacial Eustasy and the Rotation of the Earth", deals with the causes of secular deceleration of the earth's rotation and the consequent acceleration of the moon (*Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 6, 7; June 1953). It is shown that glacial eustasy—the rise and fall of sea-level due to the release and absorption of water in glaciated regions—may be responsible for changes in the moment of inertia of the earth, but not if complete isostatic compensation occurs. Following deglaciation of a given region, isostatic compensation results in an up-doming of the crust which formerly carried the ice load; but this isostatic compensation occurs at a very much slower rate than the regression or advance of the ice-sheet. In addition, it seems to take place only when a minimum change in the surface load is exceeded, and is non-existent with minor glacial fluctuations. For these reasons, changes in sea-level produced by glacial conditions are attended by immediate changes in the moment of inertia of the earth and then followed by a slower compensatory change of opposite sign. Climatic and glaciological considerations indicate that fluctuations of sea-level occur, and these can contribute significant amounts to the secular acceleration of the moon. Changes in tidal friction due to a rise in sea-level are shown to have been very small and could not be responsible for the moon's apparent acceleration. There is fairly good evidence that there is a rise in sea-level at present, in consequence of which tidal friction is changing, but only slightly.

An Oil Palm Journal

THE Director and Staff of the West African Institute for Oil Palm Research are to be congratulated on the interesting contents and pleasing format of the first number of their *Journal*. The *Journal* can be purchased from the Institute, near Benin City, Nigeria, or from the Crown Agents for the Colonies, 4 Millbank, London, S.W.1; price 2*s*. 6*d*. The inception, development, organization, staff, aims and achievements of the Institute are described by the director, Mr. F. W. Toovey. A long article by Dr. J. M. Waterston deals with the origin and history of Nigerian palmeries, the effect of ecological factors on the incidence of disease, and the major diseases thus far reported. An important feature of this article is a check list of the bacteria, slime moulds and fungi recorded on the African oil palm. The controlled pollination of the oil palm is described and illustrated by Mr. C. Purvis, while more strictly agricultural matters, such as the field planting of palms, methods of germinating seed and the establishment of nurseries, are also dealt with in several articles. In this first number the editorial aim—to record the research work of the Institute and to extend the scientific knowledge of the oil palm as a plant and a crop—has undoubtedly been given a good start.

Stability of Living Organisms

THE stability of complex organic substances synthesized by living organisms is of great theoretical and practical importance. One aspect of this problem, namely, the stability of biological substances that can be expressed in terms of the time during which these substances will retain their specific biological properties and, therefore, the integrity of their structures, has been examined by Prof. D. Keilin (*Sci. Prog.*, **41**; October 1953). The problem is first considered with regard to the stability of biological materials *in vitro* and then *in vivo*. Finally, the stability of the whole complex structure of a living organism is discussed, especially when its metabolic processes are at their lowest ebb, when they are scarcely perceptible or even when the organism is in a state of anabiosis.

Population Council, Inc.: Fellowships for Advanced Training

A NEW organization, the Population Council, Inc., has recently been established in the United States as a non-profit corporation in order to encourage research

and education concerning the relationship of the world's population to its material and cultural resources. The trustees of the Council are Frank G. Boudreau, Detlev W. Bronk, Karl T. Compton, Frank W. Notestein, Frederick Osborn, Thomas Parran, John D. Rockefeller, III, and Lewis L. Strauss. The Council plans to study the problems of the increasing population of the world, to support research, and to make known the results of such research; it will also serve as a centre for the exchange of facts and information on population questions, and co-operate with individuals and institutions having similar interests. The Council does not intend to conduct research or educational activities with its own staff; but it has already made a small number of research grants to universities and other established organizations, and has established a number of fellowships for the advanced training of students in the social and natural sciences at the predoctoral or postdoctoral levels. Approximately six fellowships, for study in the United States and elsewhere, will be offered during the academic year 1954–55, to be divided between students from the United States and from other countries. The basic stipend of 2,500 dollars a year may be supplemented to provide for maintenance of dependants and, especially in the case of foreign students, for travel or exceptional expenses. Preference will be given to candidates who are not more than forty years old. Application forms for these fellowships (to be returned before February 1, 1954) and further information can be obtained from the executive vice-president of the Council, Mr. Frederick Osborn, 230 Park Avenue, New York 17, N.Y.

Eighth New Zealand Science Congress

The Royal Society of New Zealand holds triennially a New Zealand Science Congress, the purpose of which is to draw together for their mutual understanding the members of various scientific disciplines and to give the non-scientific public in New Zealand an opportunity of learning something of the status of science in the Dominion. The eighth such Congress will be held in Auckland during May 17–22, with excursions during May 23–24. The meeting will be divided between nine sections as follows: (*A*) physical sciences; (*B*) chemical sciences; (*C*) botanical sciences; (*D*) zoological sciences; (*E*) geological sciences; (*F*) geographical sciences; (*G*) medical sciences; (*H*) social sciences; and (*J*) anthropology. The sections are arranging symposia on various topics, but a noteworthy feature is that most of the symposia will be held jointly by two or more sections so that there will be a considerable cross-fertilization of ideas between workers in different branches of science. In fact, the keynote of the Congress is that the papers presented should promote the exchange of ideas and should not be highly specialized or technical. Consequently, the free movement of members between the various sections is encouraged, and, in general, the Congress is open to all, scientific or otherwise. The fee for membership is one guinea (10*s*. 6*d*. for students). Enrolment forms and further details can be obtained from the Honorary General Secretaries, Eighth New Zealand Science Congress, P.O. Box 9027, Auckland, S.E.1.

National Science Foundation Awards

The National Science Foundation, Washington, D.C., has announced 123 awards totalling about 1,332,000 dollars, these being the first group of awards to be made by the Foundation during the fiscal year 1954 for the support of basic research and related matters. The grants are made to institutions, coupled with the name of a particular person as the principal scientist, and are for research in the biological and the physical sciences, and also for the support of studies and conferences on science, the exchange of scientific information, the compilation of scientific personnel information, and travel by American scientists to international scientific meetings. The latest group of awards range in duration from 6 months to 3 years, with an average length of 1·8 years, and include scientific workers and institutions in most of the States of the United States and also Puerto Rico and Great Britain.

"Gmelins Handbuch der Anorganischen Chemie"

The publishers of "Gmelins Handbuch der Anorganischen Chemie", a standard work of international reputation, have announced that an increase in price is unavoidable and will take place immediately. It is pointed out that the preparation of such a work requires the services of a large number of highly qualified specialists, that it covers a much larger range of literature than the corresponding work dealing with organic chemistry, the well-known "Beilstein", and yet reaches a smaller number of purchasers. The proceeds from sales at the old prices covered only about a fifth of the production costs. The step of increasing the price was taken only after most careful consideration of possible alternatives and after adequate consultation. The new prices can be obtained from Verlag Chemie, G.m.b.H., Weinheim, Bergstrasse.

Announcements

Dr. F. P. Bowden, reader in physical chemistry in the University of Cambridge and head of the Research Laboratory for the Physics and Chemistry of Surfaces, has been awarded the Redwood Medal of the Institute of Petroleum. Prior to the presentation of the Medal, Dr. Bowden delivered an address on "The Friction of Solids".

Sir Wallace Akers, director of research, Imperial Chemical Industries, Ltd., has been elected president of the International Institute for the Conservation of Museum Objects in succession to Mr. G. L. Stout, director of the Worcester Art Gallery, U.S.A.

The British Oxygen Co., Ltd., has appointed Dr. P. H. Sykes, general manager (research and development), to the board of directors, and Dr. N. Booth to be general manager following Dr. Sykes.

The Medical Research Council announces that the Wernher Research Unit on Deafness, supported from funds made available to the Council by the Alexander Pigott Wernher Trust, has been transferred from the Institute of Laryngology and Otology, Golden Square, London, W.C.1, to King's College Hospital Medical School, London, S.E.5, by arrangement with the Council of the School. Mr. Terence Cawthorne will act as honorary clinical director, and Dr. T. S. Littler continues to be director of the Unit.

Erratum. In the communication entitled "Thelytokous Parthenogenesis . . . in the Desert Locust" (*Nature*, December 19, p. 1153), the figures in line 4 of Tables 2 and 3 should be in line with 'F_4 Parthenogenetically' and not in line with 'Controls', which refers to the egg-pods and hoppers produced sexually.

X-RAY ANALYSIS GROUP OF THE INSTITUTE OF PHYSICS

AUTUMN CONFERENCE

A CONFERENCE and exhibition organized by the X-ray Analysis Group of the Institute of Physics were held in London at the Institution of Electrical Engineers during November 20–21. The conference was concerned with two principal topics: a critical examination of photographic and counter spectrometer methods together with a comparison of these two experimental approaches, and a discussion of X-ray methods of identification.

Dr. R. H. Herz, who considered the fundamentals of the behaviour of photographic emulsions, outlined the Gurney–Mott concept of latent image formation: the fact that at least one grain of silver bromide is rendered developable per X-ray quantum absorbed is responsible for the linearity of the initial part of the density-exposure curve. The contrast of all emulsions, whatever their speed, is the same over this linear portion. The speed of the film increases at higher densities, and it also increases with X-ray wave-length. Both contrast and speed can be increased at the expense of heavier fogging by lengthening the time of development.

The requirements of X-ray films for various types of diffraction work were discussed by Dr. P. B. Hirsch, who said that the accuracy of the measurement of the position of diffraction lines is affected by non-uniform shrinkage; spacings cannot generally be determined to better than 2 parts in 10^5 unless a number of calibration marks are made on the camera. For the measurement of weak lines, speed and contrast are of importance. While film speeds are adequate for softer radiation, intensifying screens give a very desirable increase for molybdenum $K\alpha$ radiation. The visibility of the lines against the background is determined by film contrast, and it is thus improved at higher densities. Under favourable conditions, lines 1 per cent above background are detectable. For the accurate measurement of intensity, fluctuations of the background must be kept to a minimum, and these are more often due to stains originating during development and to impurities in the emulsion than to film graininess. A further cause was shown in the subsequent discussion to be the non-uniformity of the black paper often used to cover the film. The greatest bar to accuracy in intensity measurements is the variation from point to point of the film speed, and differences as great as 5 per cent can occur. Dr. Hirsch emphasized the need for a single-coated X-ray film, not at present available in Britain, a point on which he was strongly supported in the subsequent discussion.

Dr. C. F. Brown next surveyed some of the many types of microdensitometers. For powder work the best available design is probably based on Dobson's split-beam principle, of which a modern version is due to A. Taylor. Among microdensitometers designed for single crystal work, Dr. Brown described in detail a scanning instrument, on show in the exhibition, which is a development of a design by J. M. Robertson and R. H. V. M. Dawton. Incorporating an 'anti-log' circuit, the instrument gives a deflexion on a meter which is directly proportional to the intensity of the spot on the film. Sir Lawrence Bragg suggested that, instead of determining the light transmitted by a film, one could measure the light scattered by the developed silver grains, as had been proposed by J. C. M. Brentano. Dr. R. L. Gordon then compared the relative merits of film and counter spectrometer methods. The expense and complexity of the latter method can, in general, be justified only when a considerable volume of work is contemplated, and Dr. Gordon described his own installation, which makes use of a monitoring counter and can be used with either scalers or counting-rate meters and chart recorders. For qualitative analysis, the positions of lines can be determined very rapidly with an accuracy sufficient for the use of the American Society of Testing Materials (A.S.T.M.) index; for quantitative analysis the intensities of a few lines are best measured using scalers for the actual lines and chart recorders for the background. When carrying out an analysis using film methods, an internal standard is necessary to furnish comparison lines; but this is unnecessary with a spectrometer, where the absorption of the sample can be measured readily. One of the features of the spectrometer, however, is that it is blind, and lines not suspected of being present can easily be missed. When examining completely unknown samples, a preliminary photograph is essential.

Dr. G. D. Rieck described the new 'Norelco' spectrometer in which the detecting Geiger counter is traversed in a vertical circle over a range of 38–165°, an angular accuracy of better than 0·01° being achieved. The X-ray optical system gives a very high resolution coupled with a low background. The X-ray tube is mounted vertically, and its output is well stabilized; both scaling and chart-recording facilities are offered, and a special instrument allows the intensities to be recorded automatically at chosen small intervals of the angular range with a constant statistical error, a valuable feature in the study of line profiles and for the detection of weak lines.

In a paper on recent developments in X-ray counters, Dr. U. W. Arndt said that, while Geiger counters are now readily available having adequate sensitivity and stability, they cannot be used for accurate work at intensities exceeding 1,000 counts/sec. This rate can be increased about a hundred-fold with either proportional or scintillation counters. Moreover, with the former, though not with the latter, it is possible to make use of their energy-discriminating properties which allow an adequate degree of monochromatization to be obtained by the use of suitable pulse-selecting circuits. Dr. Arndt described a simply constructed argon-flow proportional counter, the long-term stability of which is superior to that of most Geiger counters. He also described some of the recent scaling and voltage-stabilizing circuits which would considerably reduce the cost of equipment for counting; examples of these were shown in the exhibition.

Dr. G. E. Bacon reviewed the techniques used in neutron diffraction work on both single-crystal and powder samples. Crystal-reflected neutron beams of a wave-length of about 1 A. are employed, for which the most useful detector is a boron-10 trifluoride proportional counter. The main differences between neutron and X-ray spectrometers are due to the much larger size of the detector and the very feeble neutron intensity available, so that large samples

must be used. Even so, counting-rates of 100 counts/min. are rarely exceeded. Absolute intensity measurements are easier than with X-rays, since the scattering factor is independent of the scattering angle. In single-crystal work zero layer lines only are measured; in this type of work extinction corrections are generally considerable owing to the large crystals employed. Dr. W. Cochran briefly considered the use of counter methods for single-crystal X-ray measurements. Here overlapping spectra are not troublesome; lower resolution and lower accuracy of angle measurement are required than in powder work, and smaller spectrometer radii can thus be employed. Integrated reflexions can be measured conveniently by using a stationary crystal close to a very broad and uniform X-ray focus. Drs. Hirsch and Rieck pointed out the difficulty of obtaining the necessary uniformity of the focal spot.

The consideration of methods of identification by X-ray crystallographic techniques was opened by Mr. H. S. Peiser, who pointed out how each problem requires different methods of approach. The enormous scope of X-ray identification methods justifies their use in nearly every manufacturing industry, for not only the constituents of a sample, but also their grain-size and nature, can often be identified by crystallographic methods.

Dr. D. M. C. McEwan described the special difficulties arising in the identification of clay minerals which may exist in the form of intimate mixtures on a molecular scale. Such structures can often be described only by their radial distributions. Frequently, the labile nature of clays causes line shifts to occur even with the simplest of preparatory treatments, and these shifts and the broadness of the bands render the standard card index inadequate. The most important information is often afforded by examining long spacings.

Special techniques are required in the identification of toxic and radioactive materials in order to safeguard the health of the operators and to prevent the fogging of the film. Some of these methods were described by Dr. J. Thewlis, who pointed out that in these cases minute quantities have to be used, the sample weighing less than a milligram. Photographic methods are employed, and the specimen is sealed in a capillary tube. With suitable precautions, samples having activities of several hundred microcuries can be photographed.

The most useful guide in the identification of most inorganic and some organic crystalline substances is the A.S.T.M. card index of lattice spacings, which now contains some five thousand cards, and the history of this index and of its continual growth and revision were related by Dr. A. J. C. Wilson, who has been in charge of the British part of this venture since 1942. A new type of index card is being produced which contains much more information than the old pattern. A set of 'Keysort' cards is now available, as are alphabetical and grouped indexes in book form. New and more accurate data are being substituted for the older information, spectrometers being used instead of powder cameras.

The need for supplementing information obtained from lattice spacings by other data was urged by Mr. R. Brooks. A consideration of the absorption of the sample, and of the type of fluorescent radiation it produces, often gives important clues, as do line broadening and the presence of preferred orientation. When single crystals are available axial lengths can be measured. Colour, refractive index, morphology and infra-red spectra may be of importance in addition to X-ray data.

Dr. K. W. Andrews said that he has found it more convenient at times to use one's own collection of known patterns than to employ the A.S.T.M. index for identification. In Mr. G. H. Cockett's experience, the use of lithium fluoride-reflected radiation is very valuable in identification problems, and he also makes frequent use of X-ray fluorescent analysis. Prof. J. D. Bernal suggested that the problems of analysis could be simplified by breaking up the complete A.S.T.M. index into groups of related substances; the weakest lines, the longest spacings, or 'lonely lines' of a pattern are often more characteristic of a substance than the strongest line. Prof. E. G. Cox announced that he is investigating the best method of indexing single-crystal data for identification purposes.

A valuable feature of the conference was the unusually extensive exhibition. An informative and stimulating evening discourse was delivered by Dr. R. W. G. Wyckoff, whose subject was "A Survey of X-ray Diffraction in the United States". The next conference of the Group will be held in Cambridge during April 1–2, 1954, and will be devoted to modern structure analysis.

U. W. Arndt

ANTIBIOTICS IN PIG FOOD

Until recently the use of antibiotics in animal feeds was prohibited in Great Britain; but the Penicillin Act, 1947, has now been amended by the Therapeutic Substances (Prevention of Misuse) Act, 1953, and the Statutory Instrument 1953 No. 1174—Therapeutic Substances: The Therapeutic Substances (Supply of Antibiotics for Agricultural Purposes) Regulations, 1953—allows the use of aureomycin and penicillin in pig and poultry foods. The purpose of these additions is the improvement of growth of pigs and poultry under practical conditions, first observed in the United States[1], where antibiotics have been used on a large scale as growth promoters for several years now. The Ministry of Agriculture has now issued Advisory Leaflet No. 418, "Antibiotics in Livestock Feeding" (H.M.S.O. 2*d*.).

In October 1951 the Agricultural Research Council called a meeting to decide whether the available findings justified the use of antibiotics in Britain. By that time, many American publications had confirmed the value of antibiotics; but British experimental evidence was still very limited[2], and in view of the marked difference in British and American methods of pig feeding and management, further work here was thought necessary before a decision was taken. The Agricultural Research Council therefore organized further trials, which took place in 1952, and a summary of their results was published in July 1953 [3].

The trials, designed and analysed with the guidance of statisticians, were of two kinds. One was to determine the effect of antibiotic supplements on the growth-rate, efficiency of food conversion and carcass quality of fattening pigs, the other to measure their value for suckling pigs.

Six research centres were asked to work with fattening pigs. They were: the Agricultural Research Council Field Station at Compton, the British Oil and Cake Mills, Ltd., Experimental Station at Stoke Mandeville, the Harper Adams Agricultural College, the National Agricultural Advisory Service Experi-

mental Husbandry Farms at Terrington St. Clement and at Trawscoed, and the National Institute for Research in Dairying at Shinfield.

Two types of diet were used: one with white-fish meal and vegetable protein was typical of the diets mainly used for fattening pigs in Britain; in the other the protein was of vegetable origin only. Both diets were tested in two systems of feeding, the usual all-meal system and the Lehmann system in which a constant daily quantity of a meal mixture is supplemented with a gradually increasing amount of home-grown bulky foods. The antibiotics tested were penicillin given as procaine penicillin, and aureomycin included as 'Aurofac 2A', the proprietary mixture containing also some vitamin B_{12} made by Lederle Laboratories, Ltd. In most trials vitamin B_{12} was also added to the penicillin supplements and the antibiotics were tested side by side. The antibiotic content of the diets varied with centres and experiments; with procaine penicillin it was usually at 15 or 43 gm./ton (equivalent to 9 or 27 gm. penicillin) and with aureomycin at 14 and 28 gm./ton.

In all but one centre the pigs were fed according to scales for fattening pigs. The experiments began within a few weeks of weaning and continued to bacon-weight, when the pigs were slaughtered and most of the carcasses were graded by an expert. The diversity of treatments and conditions make it impossible to discuss and consider them in detail; but a clear view of the findings can be obtained from a study of the general conclusions of the report based on experiments with some five hundred pigs.

On the unsupplemented rations with animal protein, the mean daily live-weight gain was 1·17 lb. (standard error ± 0·013); with penicillin it was 1·29 lb. (S.E. ± 0·013) and with aureomycin 1·28 lb. (S.E. ± 0·015). On all-vegetable diets the figures were 1·05 lb. (± 0·020), 1·18 lb. (± 0·020) and 1·22 lb. (± 0·022). Both antibiotics, therefore, improved the growth of fattening pigs by some 10 per cent with the better diet and by 12–16 per cent with the diet containing only vegetable protein.

The antibiotics also improved food conversion; thus 3·72 lb. (± 0·038) of the unsupplemented diet was needed to produce 1 lb. of live-weight gain, whereas the same gain required only 3·45 lb. (± 0·038) food in the presence of penicillin and 3·49 lb. (± 0·041) in the presence of aureomycin.

Trials under the Lehmann system are included in these averages. On their own they also indicated benefit from antibiotics.

In the grading, carcasses of pigs given the antibiotics were indistinguishable from the others, and treatment up to bacon-weight had therefore no effect on carcass quality.

For the trials with suckling pigs, more litters were needed than were available at the research stations. Farmers were therefore invited to co-operate, and thirteen of them, mainly breeders of pedigree pigs in south-west counties of England with a standard of management above the average, took part in the experiment. They either added the antibiotic supplement to their own creep meal, or used proprietary meals with the supplement in them. Two levels of aureomycin and two levels of procaine penicillin were tested. The piglets were weighed at birth and again at weaning. With 208 litters, the following weaning weights corrected to 63 days were obtained: aureomycin, 29 gm./ton, 43·7 lb., 43 gm./ton, 40·5 lb.; procaine penicillin, 7·5 gm./ton, 40·1 lb., 15 gm./ton, 39·3 lb.; control, no antibiotic, 37·7 lb. The results were very variable, probably owing to the wide difference of conditions on the farms. In consequence, the overall differences between treatments were not statistically significant and comparisons between individual treatments are not valid. The figures nevertheless suggest that some improvement in weight at weaning may have been produced by the antibiotics. The smaller dose of aureomycin gave the biggest apparent effect.

Taken as a whole, the results of tests carried out under the ægis of the Agricultural Research Council showed the usefulness of antibiotics in British pig-farming practice. They made it clear, however, that the extent of the benefit is influenced by a variety of factors, including method of feeding, management and health conditions on the farm. Thus the value of antibiotics can only be judged by their average performance in the country as a whole or on many farms, and not by individual effect or lack of effect in any separate trial.

The report emphasizes that many practical important aspects of the use of antibiotics in pig feeding with which the trials could not deal still require investigation. Thus the experiments were not designed to study the effects of adding vitamin B_{12} with the antibiotic, and the alleged synergistic action of these substances will need to be studied. Nor did the trials extend over successive generations, and the benefit or harm of antibiotics to breeding stock should be given consideration in the future. Further work with suckling pigs is clearly needed, and the distinct possibility of beneficial use of antibiotics with runts must be explored.

Be that as it may, the trials showed that antibiotics have a place in British pig farming, and the findings of the report no doubt influenced the recent official decision about their use.

[1] Stokstad, E. L. R., and Jukes, T. H., *Proc. Soc. Exp. Biol. Med.*, **73**, 523 (1950). *Poult. Sci.*, **29**, 611 (1950). Jukes, T. H., Stokstad, E. L. R., Taylor, R. R., Cunha, T. J., Edwards, H. M., and Meadows, G. B., *Arch. Biochem.*, **26**, 324 (1950).

[2] cf. Braude, R., Kon, S. K., and Porter, J. W. G., *Nutr. Abstr. Rev.*, **23**, 473 (1953).

[3] Agricultural Research Council, A.R.C. Report Series No. 13, "Antibiotics in Pig Food". (H.M.S.O., London, 1953.)

BRITISH COUNCIL

ANNUAL REPORT FOR 1952–53

THE nineteenth report of the British Council* covers the year ended March 31, 1953, in which its grant of £2,527,100 from United Kingdom public funds was 8·1 per cent less than during 1951–52. In connexion with the appointment of the Drogheda committee of inquiry into overseas information work, the Government announced that the 1952–53 level of activity would be maintained by the British Council, by the Government information services and by the overseas services of the B.B.C.; thus it is pointless, pending the results of this inquiry, to comment on the withdrawals from Persia and China, on the reduction of activity in Europe, and on the general disposition of the Council's resources as between Europe, the Middle East, Latin America and in the Commonwealth. It is understood that the Drogheda committee has now presented its report, but that the report is not to be published for security reasons. Publication of the findings, however, seems desirable in view of criticism of overseas

* Report on the Work of the British Council for the Year ended 31st March, 1953. Pp. v+105. (London: British Council, 1953.) 2s. 6d.

information work and of Government policy in that field.

In the British Commonwealth, demands made for university interchange again increased: applications increased by 30 per cent, and, of the fifty-five travel grants made by the Council's committee for Commonwealth university interchange, forty-four were for visits to United Kingdom universities and eleven for visits to Commonwealth universities overseas. A new centre was opened in Western Uganda at the request of the Uganda Government, and separate chapters of the report are devoted to the Council's work in Nigeria and in Indonesia. In the former, the centres opened in Lagos, Enugu, Ibadan and Kano are being supplemented very successfully by the inauguration of a score of groups all over Nigeria, and the provision of libraries of British books and periodicals, the training of librarians, and the effort to lay the foundations of a nation-wide library service are important features of the work. In Indonesia, the teaching of English is the main part of the Council's work; but the Council's library is a major asset and the awards of scholarships, bursaries and visitorships are of special value.

A feature of the Council's work during the past four or five years is the success of the 'study box' scheme in providing group leaders and organizations with material for group study. The central feature of the collection of books, pamphlets and teaching aids thus provided is a study booklet, of which fifteen copies are supplied, and more than a thousand such boxes have been supplied to sixty-four different countries. In 1952 the Council undertook and completed a survey of the visits to Britain during 1951 of twelve hundred overseas scientific, engineering and medical graduates for research and advanced study, and of the corresponding visits of British scientists abroad. About 40 per cent of these were concerned with medicine. The Council now has only two scientific officers overseas, in Italy and in Brazil, and the large development of the Council's scientific work in Brazil is attributed partly to the latter officer. Medicine and other sciences accounted for about 29 per cent of visitors to the United Kingdom during 1952–53, for whose programmes the Council had responsibility. Reference is made to the close co-operation between the Council and the Department of Scientific and Industrial Research and other scientific bodies in Britain and to the tribute to the Council's scientific work in Latin America paid in the report of the recent training mission of the Federation of British Industries.

Overseas visitors to Britain for professional study with whose visits the British Council was associated during 1952–53 totalled 3,619, including 417 United Nations Fellows and Scholars and 245 trainees under the Colombo Plan. Of the subjects of study, science accounted for 591, social science 1,097, medicine 481 and education 481. Besides this, the British Council met on arrival 3,097 overseas students, accommodated 548 in its residences, arranged accommodation for 242 in university halls of residence and hostels and for 1,657 in lodgings. Some four thousand students were enrolled as members of British Council centres for social and cultural activities and attended study-visits arranged to factories, museums, etc., while 1,647 attended vacation courses of seven to fifteen days duration. During 1952–53 about one hundred lecture tours overseas were arranged, of which thirty-five were in Europe, eighteen in Dominion countries and twenty in the Colonies; 40 per cent of these tours were concerned with science, engineering, medicine or agriculture.

The report of the British Engineering Mission which visited Latin America for the Federation of British Industries recommended that at least a hundred engineering scholarships a year for the countries of Latin America and a proportionate number for other developing parts of the world, both in the British Commonwealth and elsewhere, should be provided. In a tribute to the work of the British Council in Latin America, the Mission urged that Britain should develop a new and favourable outlook to the training of overseas engineering graduates, accepting increasing numbers for training, planning and co-ordinating proper graduate training courses, and cultivating these carefully selected students socially so that they return to their countries friendly disposed to Britain. In this connexion the British Council's report notes that of 394 British Council scholars and bursars who visited Britain during 1952–53, 193 were concerned with scientific subjects, 77 with medicine and 36 with engineering; of 192 scientific visitors for whom the Council made arrangements, 28 were concerned with engineering, 25 with agriculture and 109 with medicine; of the United Nations Fellows and Colombo Plan trainees, 170 were concerned with medicine, 90 with agriculture and 92 with engineering. Of 161 private students of scientific subjects passing through the Council's hands, 50 were engineers and 83 were concerned with medicine and nursing.

NATIONAL RESEARCH COUNCIL OF CANADA

REPORT FOR 1952–53

THE thirty-sixth annual report of the Canadian National Research Council covers the year ended March 1953* and includes, besides the president's report and the financial statement, the annual report of Canadian Patents and Development, Ltd., for the year ended March 31, 1953. During the year this corporation conducted pilot-plant operations, with promising results, on the Cambron process for ethylene oxide, by catalytic oxidation of ethylene. The corporation continues to handle patent matters arising out of the atomic energy project and also to supervise patents on inventions resulting from development work being carried out by A. V. Roe, Canada, Ltd., on contracts relating to the gas turbine engine and aircraft. It now has agreements for handling patent and licensing matters for five Canadian universities and two Provincial research councils.

The president's report records satisfactory progress during the year in all Divisions of the National Research Council despite slight disruption of work due to rehousing of some laboratories. The post-doctorate fellowship plan, inaugurated in 1948, continues to bring a steady flow of young scientific workers from the universities of the world, and their presence has the stimulating effect of creating a sort of university atmosphere in the Council's laboratories as well as making available a wide diversity of training and experience. More than 275 scholarships and fellowships for research were awarded by the Council in 1952–53; in addition, 75 postdoctorate

* Thirty-sixth Annual Report of the National Research Council of Canada, 1952–53. Pp. 54. (Ottawa: Queen's Printer, 1953.)

fellowships were currently held in the Council's laboratories, and a scheme for similar fellowships tenable in Canadian universities were introduced, under which five awards were made for 1952–53.

In the Division of Applied Biology studies on dairy products continued at both the applied and fundamental levels. It has been found that the salt content of one halophilic bacterium remains constant at about four per cent when the salt concentration of the medium is increased from 8 to 20 per cent, while one of the enzymes in another halophilic organism is inactivated when the salt concentration of the medium falls below 12 per cent. Growth of this class of organism is stimulated by nitrogenous extract from yeast, and a definite need for potassium has been established. A test-room has been designed and constructed for studying the possibilities of maintaining higher relative humidities in cold stores to prevent the surface drying of perishable foodstuffs during frozen storage. The yield of butylene glycol by bacterial fermentation has been increased by small additions of an anion exchange resin, and the production of citric acid from beet molasses in 6-in. glass towers has been undertaken. Further study has shown that the activity of the enzyme responsible for the destruction of cellulose, which has been extracted from one of the textile-rotting moulds, is inhibited by traces of acid dyes and stimulated by basic dyes and proteins. Studies have been made of the resistance of warm-blooded animals to cold, and biochemical methods and microscopic radio-autography have been used to trace the path followed by radioactive carbon in photosynthesis. Improved procedures have been developed for the extraction and chromatographic separation of phosphate esters from leaves.

In the Prairie Regional Laboratory, Saskatoon, work on the production of ustilagic acid has been advanced to the pilot-plant stage, and rare carbohydrates, including sugars, sugar alcohols and aldonic acids, representing five-, six- and seven-carbon compounds, have been prepared for studies on the comparative carbohydrate metabolism of bacteria. Complete control of loose smut of barley was obtained by treatment of infected seed with two out of thirteen antibiotics tested, but not in similar trials on treated seed grown to maturity in the greenhouse. A process has been developed for the isolation from wheat flour of a starch-free gum containing high percentages of pentosans; and investigations on the anaerobic fermentation of radioactive glucose by *B. subtilis* (Ford's type) indicate that glucose is converted to pyruvate by Emden–Meyerhof reactions, and that the pyruvate is decarboxylated and condenses to form a 2 : 3-butylene glycol precursor. As a result of investigations which have shown that the mechanisms of the α- to β- rearrangement of the glucose penta-acetates in chloroform solution catalysed with stannic chloride, and in acetic acid – acetic anhydride, are identical, a new method has been established for the preparation of β-glucosides. The construction and equipment of pilot-plant control and development laboratories in fermentations, straw utilization and processing on a scale of 5–20 gallons have been completed; and fluid bed techniques have been applied to problems of drying wheat.

In the Division of Pure Chemistry, the structure of a hitherto unknown isomer of sparteine has been elucidated, and kinetic studies of the hydrolysis of benzylideneanilines and of diazoacetic ester were completed. An infra-red absorption study established that methyl and methylene groups in sterols can be identified from the spectrum: this has been confirmed by studies on deuterium-substituted sterols, and the infra-red spectra of saturated and unsaturated acids and esters have been studied qualitatively, and those of the steroid sapogenins quantitatively. Measurements on binary liquid mixtures have shown that the velocity of sound decreases and the absorption increases as the critical temperature is approached. Measurements were completed of the thermodynamic properties of oxygen and nitrogen absorbed on titanium dioxide, and an investigation has been initiated of the chemistry of substances at higher temperatures. A mathematical theory, descriptive of the flow of adsorbed material, has been developed which permits correlation between pore sizes, adsorption isotherms and flow-rates, while the investigation of the absorption of acids by wool has been continued.

In the Division of Applied Chemistry the process for the catalysed air-oxidation of ethylene to ethylene oxide has been developed to the industrial pilot-plant stage, and a new procedure has been developed for reactivating catalysts poisoned by atmospheric traces of sulphur dioxide, hydrogen sulphide and halogens. The preparation of silver catalysts by dip-coating silver in calcium–magnesium–silver alloys was a major activity in the metallurgical chemistry section, and the examination of the flow properties of silica in oil pastes indicated that they are less influenced by temperature changes than are the corresponding soap–oil systems. Other investigations relate to the thermal breakdown of polymethyl methacrylate, the metallographic examination of hot-water tanks, the application of the fluidized solids technique to the processing of Alberta bituminous sand, the production of petrochemicals and of sulphur from pyrites and the utilization of industrial wastes, the sorption of surface-active compounds by textile fibres and the mode of action of fungicides, such as copper 8-hydroxyquinolinate, in preventing microbiological breakdown of cellulose textiles.

In the Division of Physics contributions have been made to the knowledge of the behaviour of the alkali metals over a wide range of temperatures, from 200° C. to a few degrees above the absolute zero. Studies of the anomalous minimum of electrical resistance at low temperatures in copper, gold and magnesium have led to a fundamental investigation on thermoelectricity in metals at low temperatures, and work on the superconductivity and the threshold curve of tantalum and niobium has been extended to lead. An investigation of the spectrum of the ionized nitrogen molecule has been completed and that on the infra-red spectra of hydrogen cyanide and acetylene and their deuterated molecules has given precise values for the internuclear distances. In the Department of Applied Physics the redesigned fog-horn and diaphone has operated satisfactorily at Prescott for some months, and further installations are under construction. Most of the apparatus required for measuring gravity by direct observations on a falling body has been constructed, and the interferometry work of the Division has been augmented to obtain data on the performance of the isotopes which have been suggested as international wave-length standards. Equipment has been constructed for a statistical study of the brightness and contrasts present in outdoor scenes as a basis for testing the performance of photographic lenses and cameras, and a film resolving-power camera has been set up to study the resolution capabilities of photo-

graphic films and plates when used with an optical system as near perfect as possible; a study has also been commenced to obtain quantitative data on the dimensional accuracy and resolution of the multiplex system of photogrammetry.

The Maritime Regional Laboratory, Halifax, opened officially on June 16, 1952, plans at first to pursue investigations on fundamental and applied aspects of the commoner seaweeds of the Maritime Provinces. The Division of Medical Research made 162 grants for experimental projects, including thirteen for investigations in bacteriology and antibiotics; twenty for research in anatomy, histology, development and ageing; thirty-six for work on biochemical and metabolic problems in normal and pathological processes; and fifty-two for studies in physiology, pathology, pharmacology and surgery. The Division of Building Research continued to study heat and moisture problems in house walls, and by the spring of 1953 expected to have seven outside corrosion-test sites in operation across Canada, while much time has been spent on fundamental studies of the treatment of fire protective measures in building codes. The Division of Mechanical Engineering has developed a small semi-diesel marine engine with a reversible propeller for inshore fishing boats; besides studies in the gas-turbine field, on structural fatigue, and on heat transfer at high rates from metals to liquids, it is continuing its comprehensive investigation of aircraft de-icing. In the Division of Radio and Electrical Engineering, where defence projects still comprise the major part of the work, a notable contribution has been made in the extension of the theory of slotted wave-guide arrays, which will result in smaller radar antennæ and clear radar pictures in merchant marine applications.

MIGRATION FROM BRITAIN SINCE 1815

As a compilation of the available statistics relating to external migration since 1815, economists and others interested will welcome a publication on the subject from the General Register Office, written by M. H. Carrier and J. R. Jeffery*. Relevant statistics from the Censuses, the records of the Colonial Land and Emigration Commission, the Board of Trade, Home Office and National Register have been brought together, with useful notes on their scope and limitations. So far as possible, the migrants are classified according to country of origin and destination, age, sex, marital state and occupation.

The data provide almost a text-book illustration of the 'undesigned' nature of most British economic statistics. They are, in fact, almost entirely by-products of administrative activity and not the outcome of attempts to measure directly the volume of migration. The figures for 1815–42, for example, are derived from the muster rolls of the ships leaving British ports, the administrative purpose of which was to ensure that the vessels carried sufficient food and drink. For this reason alone, these statistics distinguish between children and adults. Nevertheless, the authors have found it possible to present in broad outline an account of emigration from the United Kingdom since 1815, and of changes in the type of person emigrating. The great volume of emigration is demonstrated: more than twenty million persons are supposed to have left the United Kingdom as emigrants during the nineteenth century. The discussion of the short-term fluctuations in the number of emigrants includes a survey of the changing attitudes of official and unofficial opinion to the emigration question and of various schemes for assisting or controlling it.

A complete account of this topic would involve an extensive discussion of the shifts since the beginning of the nineteenth century in public opinion on the population problem in general, and would have taken the authors far beyond the immediate scope of their paper. It must, however, be said that the discussion of the economic factors involved is superficial. The diagram on p. 21 does not seem to bear out in detail the simple 'repulsion' explanation of emigration to which in the last resort the authors subscribe. The curve of emigration seems frequently to reach its peaks several years after acute economic depressions, so as to attenuate the correlation between the volume of emigration and the level of economic activity. Similarly, emigration from Ireland did not reach its peak until four years after the potato famine of 1846–48. An adequate explanation of fluctuations in the volume of emigration would have to take into account a great many factors, including changes in the volume of British investment in the New World.

It is perhaps unfortunate that, unwilling to embark on such a complete account of the subject, the authors have not limited themselves strictly to compiling a statistical source-book. The production of the paper is deplorable. The use of 'type-writer' fount and a foolscap page has made the volume unpleasant to read and awkward to shelve. By Stationery Office standards it seems over-priced.

E. J. M. Buckatzsch

* General Register Office. Studies in Medical and Population Subjects: No. 6, External Migration, a Study of the Available Statistics, 1815–1950. By M. H. Carrier and J. R. Jeffery. Pp. 163. (London: H.M.S.O., 1953.) 8s. 6d.

HUMAN RELATIONS TRAINING FOR SUPERVISORS

The importance of supervisory behaviour in influencing employee morale and productivity has been increasingly recognized in industry. The number of industrial concerns providing some course of training for supervisors has gradually increased, although the content and length of these training courses vary considerably from firm to firm. Recent investigations by W. H. Scott and Ian McGivering were designed to assess the extent to which they are capable of effecting change in the behaviour and relationships of supervisors in their everyday work situation (*Occupational Psych.*, **27**, No. 3; July 1953).

As part of their preliminary observations, they attended a series of courses provided for its supervisors by a large manufacturing concern.

The investigation was purely exploratory, yet their impressions and tentative conclusions run counter to some current assumptions about the organization and effects of supervisory training. The investigators attended five similar and consecutive courses, each lasting one week, 'sitting in' as observers; they also interviewed individually as many of the supervisors as circumstances permitted.

The supervisors' attitudes towards 'staff' specialists tended to change during the course. The tensions which frequently exist between line and 'staff' in industry have received some attention during recent

years, and many of these supervisors were rather antagonistic towards 'staff' specialists at the beginning of the course. The appreciation of the functions, aims and difficulties of the various specialists which the supervisors gained by meeting them on the courses seemed to lead to some modification of attitude.

When the supervisors as a body considered the 'problems' presented to them, discussion seldom rose above the level of a discursive exchange of views which tended to encourage the mutual confrontation of prejudices, often with elaborate rationalizations in support. On these courses the free discussions often seemed to reinforce the very attitudes they were designed to change. In so far as they led to a more detached approach, this seemed to be negative rather than constructive, and was marked by scepticism rather than by a willingness to face and to consider the merits of solutions which did not necessarily accord with the individual's preconceptions.

Another pattern of behaviour, superficially different but basically similar, emerged whenever supervisors took part in other types of group discussion. Members identified themselves closely with their syndicate, so that when the time came to report back, a debate rather than a discussion developed, and each syndicate tended to defend its own point of view regardless of the merit of contributions made by the other syndicate. Under the pressure of the report-back situation the syndicates tended to prepare a case to support a particular point of view, rather than to examine objectively the merits of a variety of points of view.

Further evidence of the shortcomings of the discussions on these courses was provided by the frequency with which the supervisors asked for a model answer to be given by the course leader or some other authority. When the individual members of the syndicates found themselves in agreement they were well satisfied, and felt that the problem before them had been solved. On the many occasions when there was disagreement lively discussion ensued during which each defended his own ideas and preconceptions and attacked those of others. All were quite confident that the correct solution had been achieved when agreement was reached, whereas, on the other hand, when disagreement was marked the group was often left in doubt as to the merits of the various solutions proposed. In the latter event, however, there would frequently be an appeal to arbitration, a request for some authoritative judgment against which these solutions could be evaluated.

An attempt was also made to determine to what extent the courses dealt with the actual problems which the supervisors experienced in their work.

The particular source of dissatisfaction which was mentioned most frequently was the relationship between the supervisor and his manager. Supervisors spoke in the main of their managers' remoteness or inaccessibility, of managers being out of touch with them and with shop-floor realities, and of a generally unsatisfactory state of communication between supervisor and departmental manager.

Those who considered that their relations with other supervisors were one of their main problems mentioned not only inter-departmental friction but also a lack of co-operation from colleagues in their own departments.

The courses appeared to achieve positive results in three directions. They were successful in improving the supervisors' knowledge of personnel policies and services, and thus should enable them to make a more effective contribution to the smooth working of existing procedures. Concerning relations between supervisors and personnel officers, it cannot necessarily be assumed from the changed attitudes towards 'staff' personnel, which were evident towards the end of each supervisory course, that actual working relations would be improved, for the members of the personnel staff with whom supervisors normally have dealings are the subordinates of the managers who addressed each course. Finally, each course promoted improved relationships between the supervisors who took part in it.

On the other hand, it seemed unlikely that any other changes of an enduring nature in the behaviour or relationships of the supervisors would result. The evidence from the interviews suggests that many of the main problems of supervisors arise from their social relationships at work.

The investigators believe that while their studies stress the urgent need for more systematic evaluation of existing training arrangements, they also point to the desirability of a more experimental approach to training. The practitioner may find that a willingness to experiment in the development of training programmes may prove of greater value than a slavish adherence to the *ad hoc* course; it would also facilitate evaluation, for research should be more rewarding if it were possible to study systematically a variety of arrangements.

ALPHA- AND BETA-FORMS OF POLY-L-ALANINE

By Dr. C. H. BAMFORD, L. BROWN, Dr. A. ELLIOTT, W. E. HANBY and I. F. TROTTER

Research Laboratories, Courtaulds, Ltd., Maidenhead and Coventry

THE existence of folded and extended forms of synthetic polypeptides is now established beyond doubt[1]; but well-crystallized samples of the same polypeptide in both forms have not hitherto been obtained. We have recently found that poly-L-alanine can be produced in highly crystalline and well-oriented α- and β-forms, and here we give a preliminary account of the chief features of their X-ray diffraction patterns. Poly-L-alanine is particularly important from the point of view of structure determinations, since the side-chains, consisting of single methyl groups, are restricted to two configurations corresponding to the extra-chain valencies of the α-carbon atoms, apart from possible distortion.

The X-ray diagrams are shown in Fig. 1 *a*, *b*. The α-diagram (Fig. 1*a*) is generally similar to that of poly-γ-methyl-L-glutamate[2]. The equatorial reflexions fit accurately a hexagonal cell with $d_{10\bar{1}0} = 7{\cdot}40$ A. As with poly-γ-methyl-L-glutamate, it is not easy to fix the exact length of the *c*-(fibre) axis. The layer lines are close to the positions corresponding to $c = 27$ A., but there is a sharp meridional reflexion at 4·4 A. which, if part of the same system, necessitates a longer repeat, for example, 70·4 A. A similar reflexion at 4·3 A. was found in poly-γ-methyl-L-glutamate, in which the length of the *c*-axis is at least 43 A. The 4·4-A. reflexion in poly-L-alanine could only be observed when the specimen was tilted appropriately, because of the high orientation of the sample. It does not appear, therefore, in Fig. 1*a*. As we have already mentioned, such a reflexion cannot arise from an undisturbed α-helix, and its

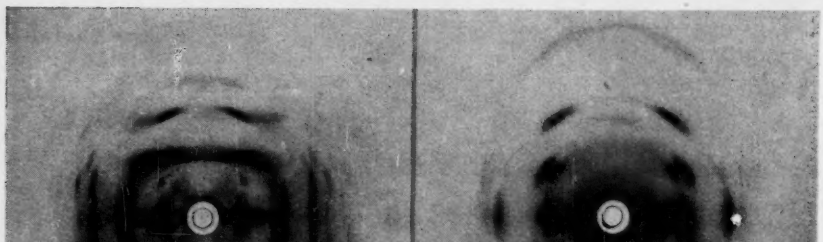

Fig. 1. X-ray diffraction patterns of (*a*) oriented α-poly-L-alanine; fibre axis vertical; copper *Kα* radiation; cylindrical camera, nominal radius 3 cm.; (*b*) oriented β-poly-L-alanine. Other details as in (*a*)

presence in poly-L-alanine as well as in poly-γ-methyl-L-glutamate shows that it is not produced by different configurations of flexible side-chains. It might, however, arise from distortion of some of the methyl groups due to difficulties in packing (see later). Only a slight distortion may be necessary, since the geometrical factor is very favourable for meridional reflexions.

No reflexion has been observed which necessitates increasing the base of the unit cell (in contrast with poly-γ-methyl-L-glutamate), and there is therefore only one chain per unit cell.

The general distribution of intensity over the layer lines is strikingly similar to that in poly-γ-methyl-L-glutamate[3] and agrees well with the calculations of Cochran, Crick and Vand[3] based on the α-helix. The equatorial intensities also agree satisfactorily with those calculated from the co-ordinates of the atoms of the α-helix derived from the most recently published dimensions of the polypeptide chain[4]. In addition to the 1·495-A. meridional reflexion, a second spot appears on the same layer line on the first row line. The relative intensities of the two reflexions are approximately as predicted. The distribution of intensities on other layer lines is being compared with the calculated one, and as a result some changes in the atomic co-ordinates may be necessary.

The value $c = 27$ A. would, of course, correspond to an α-helix having 18 residues in five turns. As mentioned earlier, however, it is necessary to consider larger values of c, and in our opinion $c = 70{\cdot}4$ A. gives the best agreement between the calculated and observed positions of the layer lines. This would correspond to an α-helix with 47 residues in thirteen turns. A consideration of the packing of α-helical chains of poly-L-alanine shows that with $d_{10\bar{1}0} = 7{\cdot}40$ A., steric interference between methyl groups on adjacent helices will arise. Further, the number of methyl groups per turn subject to this interference depends on the turn ratio of the helix, and for different helices goes down in the order $18/5 > 29/8 > 47/13$. The turn ratio of the helix may therefore be influenced by the packing of the side chains, and would be expected to be such as to give closest approach of neighbouring helices with minimum distortion of methyl groups. The slightly different turn ratio (29/8) observed for poly-γ-methyl-L-glutamate[3] is consistent with this idea.

An X-ray photograph of β-poly-L-alanine taken with the specimen tilted at an appropriate angle shows the strong meridional reflexion at 1·147 A. which we have already reported[5]. This fixes the *c*-(fibre) axis as 6 × 1·147 = 6·88 A. The 1·147-A. reflexion does not appear in Fig. 1*b*, since for this photograph the beam was normal to the specimen. The unit cell appears to be orthorhombic with $a = 4{\cdot}79$ A., $b = 10{\cdot}7$ A., $c = 6{\cdot}88$ A., and contains two chains. In a β-polypeptide the chains may be hydrogen-bonded into sheets in two ways: a 'parallel' sheet has all the chains parallel and running in the same direction, whereas an 'antiparallel' sheet has neighbouring chains running in opposite directions. Satisfactory models of either type can be constructed in which the *c*-axis is 6·88 A. These sheets may be packed in parallel and antiparallel arrangements. The X-ray evidence shows that neither parallel sheets packed in a parallel manner nor antiparallel sheets can be present as major constituents of β-poly-L-alanine. The former would correspond to only one chain per unit cell, while the latter would require doubling of the *a*-axis. There is no evidence that a unit cell larger than that given above is necessary. It seems that the most probable arrangement is one in which sheets of parallel chains are packed in an antiparallel fashion.

Density measurements on these preparations are not satisfactory, because although the crystalline phases appear to be fairly pure α or β as the case may be, infra-red spectra show that the amorphous regions contain appreciable amounts of the other component.

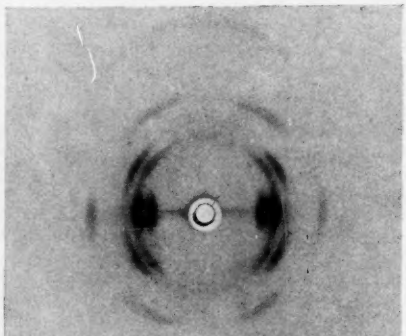

Fig. 2. X-ray diffraction pattern of Tussah silk. Other details as in Fig. 1 (*a*)

In conformity with results obtained on other polypeptides, poly-L-alanine shows different solubility behaviour in the α- and β-forms. For example, the α-polymer dissolves in dichloracetic acid, but the presence of a small amount of β prevents solution.

In conclusion, we would point out the remarkable similarity between the X-ray diffraction photographs of β-poly-L-alanine and Tussah silk (Fig. 2). The spacings and the general distribution of intensity are almost identical in the two cases. There is, however, a complete absence in Tussah silk of the poorly oriented diffuse equatorial arc at 7·4 A. arising from α-material, some of which is always present in 'β' specimens of poly-L-alanine. The reflexions for Tussah silk may be indexed in terms of the two-chain orthorhombic unit cell suggested for β-poly-L-alanine, the difference in the cell dimensions in the two cases being less than 0·5 per cent. The only major difference in relative intensity is that of the equatorial reflexion near 5·35 A., which is distinctly lower in Tussah. The amino-acid composition of Tussah silk is not known with any certainty, but the alanine content is apparently greater than in silk from *Bombyx mori*. It is reasonable to assume that the alanine in the former dominates the packing, although glycine and serine residues may also be present in the unit cell.

A detailed account of this work will be presented elsewhere in due course. [Nov. 9.

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CHLOROPHYLL CONTENT AND CARBON DIOXIDE UPTAKE OF STOMATAL CELLS

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THE guard cells of all light-sensitive stomata, including those of *Allium* (starch-free), appear to contain chlorophyll[1,2], and the long-postulated importance of carbon dioxide tension in controlling stomatal movement is now well substantiated[3–5]. Yet, it has never been ascertained whether or not stomatal fixation of carbon dioxide, photosynthetic or otherwise, actually occurs. All the evidence cited in favour of the former[5–7] rests upon starch increases which are open to interpretation in terms of translocation from surrounding cells, and a recent attempt to demonstrate the stomatal production of oxygen by utilizing the technique of bacterial luminescence yielded only negative results[2].

The epidermal chlorophyll content of *Tulipa gesneriana*, L. and the uptake of radioactive carbon dioxide by isolated epidermis of tulip, *Vicia faba*, L. and *Allium cepa*, L., have now been determined in an attempt to gain new information regarding the mechanism of stomatal movement. For chlorophyll determination, a sample of approximately three grams fresh weight of tulip epidermis was prepared from freshly harvested, healthy leaves of field-grown plants by a group of workers. The individual strips (0·5–1 cm. × 2–4 cm.) were carefully scraped and washed to remove adhering mesophyll and the chlorophyll extracted by repeated grinding with acetone and ether in a dark room. The final (anhydrous ether) extract was examined in a Beckman spectrophotometer (D.U.) and the quantities of total and chlorophylls *a* and *b* present calculated[8]. The presence of chlorophylls *a* and *b* was confirmed by paper chromatography. A similar analysis was carried out simultaneously using whole leaf tissue. The results are given in the accompanying table together with estimates of guard-cell chlorophyll which were calculated from the fresh weight/cm.^{2} and stomatal frequency/cm.^{2} of epidermis.

	Epidermis			Ratio *a* : *b*	
	a	*b*	*a* + *b*	Epidermis	Leaf
% fresh weight ($\times 10^{-4}$)	2·46	1·36	3·82	1·81	3·45
Gm./guard cell ($\times 10^{-12}$)	1·81	1·00	2·81		

The validity of these estimates clearly depends upon the success with which the epidermal strips were freed of mesophyll. The stomata alone among the epidermal cells of tulip contain visible green plastids giving microchemical tests for chlorophyll. The difference between the ratios of chlorophyll *a* : *b* for the epidermis (1·81) and whole leaf (3·45) suggests that a part, at least, of the chlorophyll in the extract was stomatal in origin. It may be calculated from these ratios that the minimal chlorophyll content/guard cell is $0{\cdot}47 \times 10^{-12}$ gm. of chlorophyll *b*. However, the guard cells presumably also contain some chlorophyll *a* and their total chlorophyll content probably lies between 0·47 and $2{\cdot}81 \times 10^{-12}$ gm./cell. According to Freeland[2] the pigment in the epidermis (stomatal cells) of *Hymenocallis littoralis*, Salisb. is mainly chlorophyll *a*.

Similarly prepared epidermal samples of tulip were used for the measurement of carbon dioxide fixation. The strips, floated cuticle uppermost on water, were exposed for three hours at 26–27° C. in sealed 18-litre glass jars to carbon-14 dioxide in light (300 foot candles) and darkness respectively. The total carbon dioxide concentration was approximately 0·03 per cent by volume, and equal quantities of $^{14}CO_2$ were supplied to each jar. Following exposure, the samples were washed in dilute acid and then with water to remove adsorbed $^{14}CO_2$ dried, ground to pass a sixty-mesh sieve and the activities determined directly at infinite thickness using a gas flow counter. Carbon dioxide uptake in the light (0·1181 μC./gm. dry weight) was approximately twice that in the dark (0·0672 μC./gm. dry weight). This result was confirmed by micro-autoradiographs of individual strips mounted on slides. Autoradiographs were made using Kodak X-ray film and *NTB* nuclear track plates. These yielded the information, revealed by microscopy, that carbon-14 had accumulated in the stomatal to a markedly greater extent than in the surrounding cells during the light exposure. This is illustrated in Fig. 1. Fig. 1*A* shows a micro-autoradiograph of a portion of a 'light' strip, while Fig. 1*B* shows the relative positions of radioactive centres and stomata respectively. In all radiographs active centres always corresponded exactly with stomatal positions, though usually some stomata (5 out of 27 in Fig. 1) showed no activity. This discrepancy was sometimes due to imperfect contact between the emulsion and the tissue strip, but

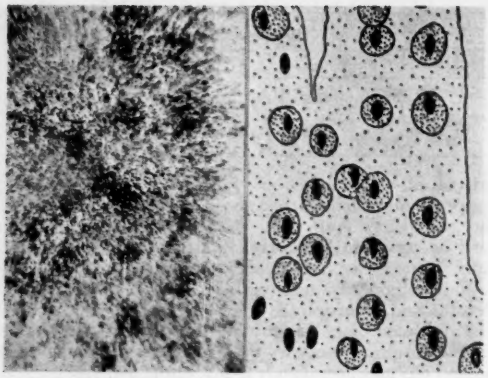

Fig. 1A Fig. 1B

Fig. 1A. Microautoradiograph of tulip epidermis in contact with X-ray film for 3 weeks. Dark areas indicate radioactivity. Experimental treatment: 3 hr. illumination at 300 foot candles in $^{14}CO_2$: total CO_2 conc. 0·03 per cent approximately. 1B, The relative positions of the radioactive centres (ringed with heavy stippling) and the corresponding guard cells (solid black); 5 out of 27 stomata do not show activity

probably more often to the early death of the cells concerned as a result of the experimental treatment. Neutral red staining indicated that 70–90 per cent of the guard and epidermal cells survived both pretreatment and exposure. Accumulation of radioactivity following light exposures has also been demonstrated for the stomata in cleaned epidermal strips of *Vicia* and *Allium*.

It seems unlikely that the enhanced carbon dioxide fixation observed in the light was due to non-stomatal photosynthesis, since any mesophyll cells not removed by the preparative treatment were certainly broken and the chloroplasts, being freely exposed to water, must quickly have swollen and burst. Moreover, the autoradiographs did not reveal the presence of large patches of high radioactivity such as would be expected from fixation by adhering mesophyll debris. The difference between light and dark uptake of tracer carbon dioxide (0·0509 μC./gm. dry weight) was therefore assumed, for purposes of calculation, to be due to stomatal photosynthesis, which was estimated from the specific activity of the carbon dioxide in the gas phase to be $1{\cdot}56 \times 10^{-12}$ mol. CO_2/guard cell/hr. under the conditions employed and assuming a steady state throughout the three-hour exposure period. This is equivalent to the production of $0{\cdot}26 \times 10^{-12}$ mol. or $4{\cdot}86 \times 10^{-11}$ gm. hexose/cell/hr. and is sufficient to account for a rise in osmotic potential of approximately 5 atmos./hr. if the vacuolar volume of a guard cell is taken as 20 per cent of the total cell volume. The latter was estimated from measurements to be $6{\cdot}5 \times 10^{-9}$ cm.^{3}. Measured rates of osmotic increase during opening for a number of species range from 3 to 10 atmos./hr. Higher rates of photosynthesis are to be expected with greater illumination provided carbon dioxide tension does not become rate limiting. However, photosynthetic production of carbohydrate in the guard cells can scarcely be the sole cause of opening because this is promoted by reduction of carbon dioxide tension in the light and, if the stomata are incompletely closed to begin with, in darkness as well[3,5].

It had been anticipated that some accumulation of radioactivity might be detected in the stomata following dark exposures, if not at low (*circa* 0·03 per cent) then at high (1–10 per cent) carbon dioxide tensions, since there are obvious parallels between the well-known changes in *p*H and starch content of stomata and those which occur in crassulacean plants as a result of dark fixation. In the first radiographs to be prepared no such accumulation was observed, though the even fogging of the emulsions suggested that dark fixation (0·0672 μC./gm. dry weight in tulip) might have occurred to an equal extent in both the ordinary epidermal and the stomatal cells. In more recent experiments, dark accumulation has been observed in tulip stomata even at carbon dioxide concentrations as low as 0·03 per cent. While the point calls for further investigation it appears that this accumulation is less marked than that occurring in the light. Attempts to demonstrate dark uptake by stomata on isolated strips of *Vicia* and *Allium* have so far yielded negative results. Nevertheless, this may occur.

These results find a simple explanation in the conclusion that guard cells are capable of photosynthesis. Dyar[9] has recently obtained evidence bearing on this point, having shown that the chloroplasts of both mesophyll and guard cells of spinach photochemically reduce 'blue tetrazolium' under anaerobic conditions. Reduction is confined to the grana, and Dyar suggests that the dye may function as an oxidant in the Hill reaction. Dark fixation of carbon dioxide also appears to be characteristic of at least some stomata. It has been suggested elsewhere[6] that stomatal opening is due, in part, to a polar translocation of carbohydrate into the stomatal from surrounding cells and closure to a controlled loss. The possibility that translocation of carbon-14 following fixation may have contributed to the results obtained cannot be eliminated. Such movement, guard-cell photosynthesis and, where applicable, starch–sugar interconversion may all contribute to the increase in osmotic potential which is observed with opening. It does not seem unduly speculative to suggest that all these phenomena may depend upon the balance or competition between the rates of light and dark fixation, as determined by the intensity of illumination and concentration of carbon dioxide at guard-cell centres. The latter is clearly subject to control by the relative rates of respiration, dark fixation and photosynthesis of the leaf as a whole. In a subsequent communication one of us (M. S.) will present evidence to show that changes of carbon dioxide tension at physiological levels exert a powerful influence on the dehydration resistance and other properties of guard-cell protoplasm.

This work is being continued and will be described in detail elsewhere.

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LETTERS TO THE EDITORS

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Anaphylactoid Response in Guinea Pigs to the Parenteral Administration of Sulphate Esters of High Molecular Weight of Dextran

DURING an investigation of the biological activity of the synthetic heparinoid anticoagulant, dextran sulphate, it was noted that the parenteral administration of certain samples gave rise to a peculiar transitory reaction in guinea pigs[1]. This reaction was anaphylactoid in type, being characterized by jactitating convulsions followed by acute circulatory collapse. Although superficially resembling true anaphylaxis, it differed from the latter in that (*a*) it occurred in animals which had not been exposed previously to dextran sulphate; (*b*) it was not accompanied by severe respiratory embarrassment. No coughing, wheezing or sneezing occurred, and animals killed during attacks showed no evidence of bronchiolar constriction or pulmonary emphysema; (*c*) the reaction could not be prevented or inhibited by large doses of the antihistamine compounds which inhibit anaphylaxis[2]. Equivalent doses of the compounds producing this effect in the guinea pig did not produce similar reactions in the mouse, rat, rabbit, dog or baboon.

Investigation of the molecular characteristics of the compounds giving rise to this anaphylactoid response showed that: (1) the molecular weight of the dextran sulphate must exceed a certain critical level and that, above this, equivalent doses by weight of compounds of increasing molecular size caused reactions of increasing intensity; (2) at the critical level of molecular size a certain sulphur content must be exceeded to produce the reaction. Dextran sulphates with average molecular weights greater than 20,000 invariably produced anaphylactoid responses. Similar responses only occurred with occasional samples of smaller average molecular weight. Such samples were suspected to be unusually polydisperse. Ethanol fractionation[3] of one such sample gave a series of fractions of decreasing molecular weight (as shown by decline of their intrinsic viscosities) and demonstrated more precisely the relationship between molecular weight and capacity to produce the response (see table).

The parent neutral dextrans, regardless of their molecular size, failed to produce reactions. With dextran sulphates of molecular weights greater than 20,000, it was shown that a sulphur content of at least 10 per cent was necessary to evoke the response. On the other hand, the sulphur content of homogeneous samples with average molecular weights of 7,000–10,000 could be increased to 20 per cent without producing the reaction.

	Intrinsic viscosity	Sulphur in sodium salt (per cent)	Fibrinogen precipitation	Deposition of material in reticulo-endothelial cells	Anaphylactoid response
Original sample	0·044	17·9	+	+	+
Fraction 1	0·070	19·4	+++	+	+
,, 2	0·058	19·3	++	+	+
,, 3	0·054	20·6	++	+	+
,, 4	0·044	19·4	+	+	0
,, 5	0·035	19·6	0	0	0
,, 6	0·026	19·3	0	0	0
,, 7	—	14·9	0	0	0

It has previously been reported that dextran sulphates with molecular weights greater than 20,000 form insoluble complexes with fibrinogen and possibly other macromolecular proteins under physiological conditions[4]. This behaviour has been shown to be accompanied by alteration of the suspension stability of the blood, with resultant agglutination of the blood-cells and especially the platelets[5]. In intact rats and rabbits, the insoluble particulate precipitates so formed were shown to be phagocytosed by reticulo-endothelial cells[1] or deposited on the vascular endothelium as thrombi or emboli. Such deposits were found to be demonstrable histologically by the metachromatic reaction given by the dextran sulphate – protein complex on staining with toluidine blue. The association between these phenomena and the occurrence of the anaphylactoid response in guinea pigs is shown in the accompanying table.

Two other synthetic anticoagulants, a sulphuric ester of xylan, and a sample of sodium polyanethol sulphonate ('Liquoid') which caused similar precipitation of fibrinogen and agglutination of blood-cells, were found to evoke anaphylactoid responses of similar character in guinea pigs.

These associated phenomena have been regarded as rendering such compounds unsuitable for therapeutic use. The sensitivity of the guinea pig in producing an anaphylactoid response to samples of dextran sulphate of low average molecular weight 'contaminated' with the large molecules responsible for the phenomena has suggested this as an empirical screening-test in investigating the suitability of batches for subsequent clinical appraisal.

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Kinetic Evidence for New Participants in the Hill Reaction

A SIMPLE method for obtaining non-stationary kinetic data from photo-reactions is to use periodic illumination. The photosynthetic process of *Chlorella* and other algæ has been extensively studied in this way. The results have been confusing in that different relationships between the photosynthetic yield per flash and the interval between flashes (t_d) have been observed. They can be divided into two categories depending upon whether the period of illumination was short (10 μsec. per flash) or long (1 m.sec. per flash or greater). Under conditions of short flashes, the yield per flash reached a maximum value when t_d was about 0·03 sec.; further increase of t_d did not change the yield, nor was the maximum yield altered by variation of temperature[1–3]. With long flashes at high light intensities, greater values of t_d were required to secure greater maximum yields per flash

than observed with short-period illumination[4-6]. There has been controversy as to the source of the latter observation; some authors believing that the carbon dioxide-reducing system of *Chlorella* is involved, while others single out reactants common to both photosynthesis and the Hill reaction[3-7]. The latter reaction, named after its discoverer, Dr. Robert Hill[8], consists of the photolysis of water by isolated chloroplast preparations or whole *Chlorella* cells upon illumination in solutions of certain oxidizing agents. There is no participation of carbon dioxide.

In an investigation of factors affecting the velocity of the Hill reaction in systems of chloroplast fragments from sugar beet (*Beta vulgaris*), a very long-lived dark reaction was detected at high flash times and intensities. The reaction does not go to completion in 0·13 sec. (Fig. 1). As these preparations are incapable of utilizing carbon dioxide, it is evident that at least part of the similar effects observed by Briggs, Tamiya and Chiba and others working on algal photosynthesis must be due to reactants still existing in the Hill reaction system.

It has been found that the Hill reaction yield per flash is a function of temperature and light intensity as well as of t_d (Figs. 1 and 2). In qualitative agreement with the results of Tamiya and Chiba[6], Fig. 2 shows that the value of t_d which is needed to achieve maximum yield per flash becomes smaller when the light intensity is lowered. To facilitate kinetic analysis, the smoothed curves shown were transformed to give the relationship between the slope (or instantaneous velocity of reduction) and t_d. The transformation revealed the existence of five regions of reaction; not all regions could be observed in a single experiment. In the order of their occurrence during a dark interval, the regions are: (*a*) an initial region of constant velocity; (*b*) a rapid first-order decay; (*c*) a slower first-order decay; (*d*) another region of almost constant velocity slower than region

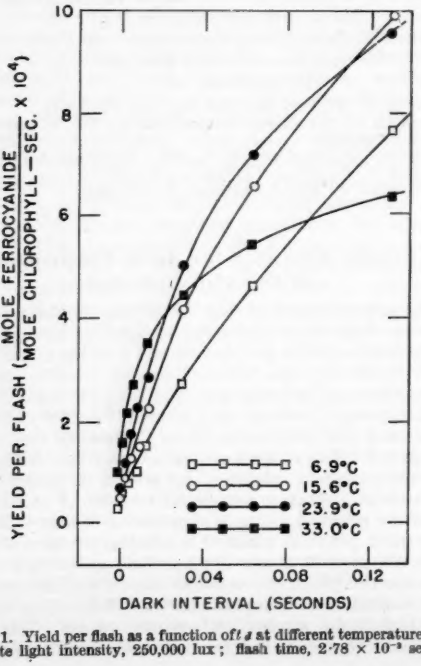

Fig. 1. Yield per flash as a function of t_d at different temperatures. White light intensity, 250,000 lux; flash time, $2{\cdot}78 \times 10^{-3}$ sec.

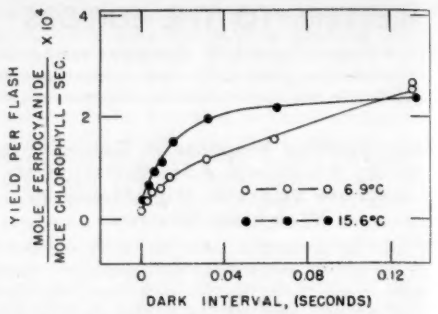

Fig. 2. Yield per flash as a function of t_d at different temperatures under conditions of low light intensities. White light intensity, 15,800 lux at 6·9° C., and 31,200 lux at 15·6° C.; flash time, $2{\cdot}78 \times 10^{-3}$ sec.

(*a*); (*e*) a region of no further reaction. At high light intensities, regions (*a*), (*c*) and (*d*) or regions (*b*), (*c*) and (*d*) are observed, depending upon the intensity, temperature and previous history of the chloroplast fragments. At low light intensities regions (*b*) and (*e*) are found.

Regions (*c*) and (*d*) are invariably observed under conditions of high light intensities. This fact suggests that a reservoir of photo-reducing power exists, and that it is operative only at high light intensities. This reservoir appears to be connected to the direct path of reducing power by slow reactions which are responsible for the existence of regions (*c*) and (*d*). The recent experiments of Clendenning and Ehrmantraut[2,3], using brief, intense light flashes, revealed only regions (*b*) and (*e*) in experiments which appeared to saturate the system. It is thus evident that not only an intense flash, but also a light interval longer than 10 μsec., are required to make the reservoir operative. The reservoir or reservoirs have a large capacity and did not approach their limit in these experiments.

A detailed analysis of these and other results will be published shortly. This work was supported by grants from the U.S. Atomic Energy Commission and the University of Utah research fund.

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Fractionation of Lignin by Chromatography

The most striking characteristic of the collection of lignin 'structures' listed by Brauns[1] is the extent of their dissimilarity. This state of affairs arises from the lack of an established criterion of purity for lignin. Purification of lignin preparations has usually been carried out according to the choice of the worker, and structural investigation undertaken without any proof of purity. Brauns's[1] admirable

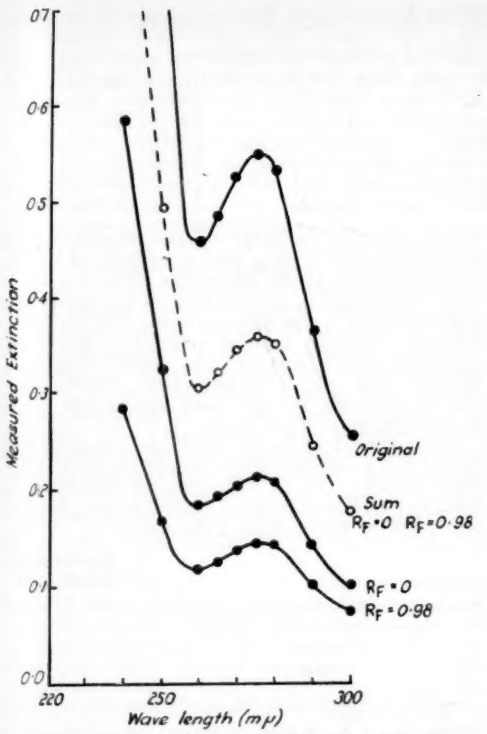

Fig. 1. Spectra of partly purified lignin and its fractions

survey on the isolation of lignin should convince any interested reader of these facts.

A great advance was made by Hibbert and co-workers[1] with the isolation of his lignin monomers, which were amenable to purification and proof of purity by established methods of organic chemistry. That at least some isolated lignins are complex has been demonstrated by Bailey[2].

Studies of the lignin extracted from *Eucalyptus regnans* wood with methanol at 150° C. have convinced us of its heterogeneous nature. This lignin retains all the usual reactions of natural lignin[3]. However, at least six constituents were disclosed by resolving with benzene on a paper chromatogram and viewing the sheet under ultra-violet light. The fluorescent areas were delineated on the sheet by a light pencil mark and, after thorough dryings, these areas were cut out and extracted with pure methanol. Blanks were also prepared by cutting out similar areas of paper at points well away from the chromatogram proper. The ultra-violet absorption spectrum of the materials extracted from the fluorescent spots was then determined using the blank solution in the solvent cell of a 'Unicam' spectrophotometer. Only the material from the spot at $R_F = 0$ gave an ultra-violet absorption curve similar to that obtained by many workers for lignins from various sources. The characteristic band was at 275 mμ as usually found for hardwoods, rather than at 280 mμ as for softwoods[1]. Materials extracted from the other spots gave absorption curves in which the band at 275 mμ was absent. We regard these materials as impurities, although it is considered likely that some of them may be degradation products of lignin, as the presence of small amounts of vanillin and syringaldehyde was demonstrated. Repeated precipitation did not rid the lignin of its impurities.

The occurrence of a spot at $R_F = 0$ cannot be taken as proof that it represents homogeneous material. Any number of substances could occur in a spot at $R_F = 0$. Further chromatographic experiments with other solvents moved the lignin spot to finite R_F values. For example, resolution with methanol : *iso*propyl ether : water (40 : 80 : 20) gave two spots at $R_F = 0{\cdot}05$ and $R_F = 0{\cdot}95$, the material from both of which gave typical lignin ultra-violet absorption curves. Resolution on a single-phase paper chromatogram with acetone : methyl ethyl ketone : water (25 : 75 : 100) gave two spots at $R_F = 0{\cdot}24$ and $R_F = 0{\cdot}28$, which gave typical lignin absorption curves.

Benzene was used in the chromatopile of Mitchell and Haskins[4] for a preliminary purification of the lignin which remained in the loaded sheet, as would be expected from the results of the benzene chromatogram. This lignin, when extracted and resolved on a paper chromatogram with *iso*butanol : benzene : water (10 : 90 : 100) gave two spots at $R_F = 0$ and $R_F = 0{\cdot}98$, with only a faint white streak in between.

Determination of the ultra-violet absorption spectra of the material from these two spots gave the results shown in Fig. 1, where the spectrum obtained from a similar amount of the original purified lignin is also shown. It may be seen from Fig. 1 that the sum of the two extinctions of the two fractions at 275 mμ amounts to about two-thirds of the extinction of the benzene-purified lignin. Methanol-extracted lignin from *E. regnans* wood therefore contains two main lignin fractions and impurities, and constitutional work on it would be invalid. This objection may apply to many other lignin preparations, and chromatographic examination of these should therefore be adopted more widely in lignin chemistry.

The isolation of homogeneous lignin fractions of relatively low molecular weight would enable a further important step to be taken towards the elucidation of lignin structure, and this now appears to be possible with the aid of chromatography.

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Inhibition of Esterases by the Fluorides of Organic Acids

During the years 1934–45, a series of organic fluorides was prepared by Schrader[1], and many of these compounds were found to be highly toxic to insects and to warm-blooded animals. More recent investigations have shown that the toxicity of some of these compounds, for example, the fluoroethanol and fluoroacetate derivatives, is due to interference with the oxidative processes in the cell[2]. The toxicity of the phosphorofluoridates, on the other hand, is due to inhibition of the true cholinesterase, and a

Table 1. Comparison of the Fluorides of Various Organic Acids
Inhibition of cholinesterases and ali-esterases *in vitro*, and relative toxicity to rats after intraperitoneal injection

Compound	Molar concentration required to produce 50 per cent inhibition				Lethal dose (mgm./100 gm.)
	True cholinesterase (rat brain)	Tributyrin-esterase (rat brain)	Pseudo-cholinesterase (rat serum)	Tributyrin-esterase (rat serum)	
Di*iso*propyl fluorophosphonate	2×10^{-7}	1×10^{-5}	8×10^{-6}	6×10^{-6}	0·4
N,N-dimethylcarbamoyl fluoride	4×10^{-7}	6×10^{-6}	3×10^{-4}	2×10^{-5}	0·7
Methanesulphonyl fluoride	1×10^{-5}	$1{\cdot}4 \times 10^{-4}$	6×10^{-5}	5×10^{-4}	0·3
Chloromethanesulphonyl fluoride	5×10^{-6}	6×10^{-5}	5×10^{-5}	2×10^{-4}	0·9
Benzylsulphonyl fluoride	1×10^{-4}	8×10^{-4}	3×10^{-4}	3×10^{-5}	15·0
Toluene-*p*-sulphonyl fluoride	7×10^{-5}	2×10^{-4}	7×10^{-5}	1×10^{-5}	(20·0)
Benzenesulphonyl fluoride	6×10^{-5}	8×10^{-4}	3×10^{-4}	$1{\cdot}4 \times 10^{-5}$	(10·0)
Phenyl fluorosulphonate	6×10^{-4}	8×10^{-4}	3×10^{-4}	4×10^{-5}	50·0

subsequent accumulation of the acetylcholine released from nerve endings[3]. The sulphonyl fluorides and carbamoyl fluorides prepared by Schrader[1] have not yet been extensively investigated.

We find that these latter compounds, although less active than the dialkyl phosphorofluoridates, are also capable of inhibiting various esterases. Table 1 indicates the concentrations required to produce 50 per cent inhibition of the true cholinesterase, pseudo-cholinesterase, and two types of ali-esterases (tributyrinases) of the rat after incubation for 30 min. at *p*H 7·4 and 37·5° *in vitro*. Data obtained with di*iso*propyl phosphorofluoridate (di-*iso*propyl fluorophosphonate, DFP) under the same experimental conditions[4] are included in order to enable a comparison to be made with a well-known dialkyl phosphate derivative.

A large number of sulphonyl fluorides and sulphonyl esters has been studied; but the most toxic member of this series, as noted previously by Schrader[1], is the simple compound methanesulphonyl fluoride[5]. This compound is very stable in aqueous solution and its toxicity to rats is, surprisingly, slightly higher than that of di*iso*propyl fluorophosphonate (Table 1); the less stable chloromethane derivative is more active than methanesulphonyl fluoride *in vitro* but is less toxic. Methanesulphonyl fluoride causes the appearance of chromodacryorrhœa, salivation, muscular fibrillation and other signs of acetylcholine poisoning when injected into rats; the true cholinesterase in the brain of these animals is found to be more than 80 per cent inhibited. The degree of inhibition of the true cholinesterase is not significantly affected by dilution of the enzyme preparation *in vitro*; moreover, the cholinesterase in the animal is still appreciably inhibited twenty-four hours after the injection of the inhibitor. It appears, therefore, that this compound is a semi-irreversible inhibitor of cholinesterase, analogous to the diethyl phosphate derivatives[6,7].

Similar results were obtained with dimethylcarbamoyl fluoride and with chloromethane-, ethane- and benzylsulphonyl fluorides. Benzene- and toluene-*p*-sulphonyl fluoride, on the other hand, have a low toxicity which is not due to cholinesterase inhibition, while the results obtained with phenyl and *p*-chlorophenyl fluorosulphonate correspond more closely to those obtained with the alkanesulphonyl fluorides. The anhydride[8] and *p*-nitrophenyl ester of methanesulphonic acid proved to be relatively inactive as cholinesterase inhibitors, although the tetraalkyl pyrophosphates and dialkyl *p*-nitrophenyl phosphates are known to be potent inhibitors of cholinesterase and highly toxic.

Various investigators have postulated that the phosphate esters attach themselves to the esteratic group of the active centre of the cholinesterase in the same way as carboxylic esters[7,9]; the anhydride-like bond is afterwards split by the esterase and a dialkyl phosphate group remains attached to the active centre of the enzyme. The esterase recovers its normal activity at a rate depending on the ease with which the dialkyl phosphate group is removed from the enzyme[7]. Data obtained previously with a phenol ester of dimethyl carbamic acid (Nu 683)[10] indicate a similar type of reaction. The results described above suggest that dimethylcarbamoyl fluoride and the alkanesulphonyl fluorides also inhibit esterases by the same mechanism as the dialkyl phosphorofluoridates.

We are indebted to Dr. B. C. Saunders, of Cambridge, for a sample of di*iso*propyl phosphorofluoridate, and to Dr. G. Schrader, of Elberfeld, for dimethylcarbamoyl fluoride, phenyl fluorosulphonate and some of the sulphonyl fluorides.

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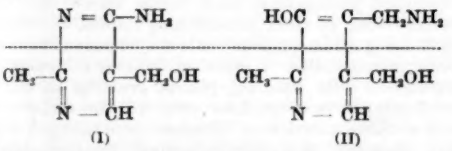
'Atoxopyrimidine'

Abderhalden[1], and later Morii[2], found that an injection of 2-methyl-6-amino-hydroxy (or halogen)-methylpyrimidine, which we called 'toxopyrimidine', in a dose of 0·12 mgm. per gm. body-weight caused attacks of convulsions and 'running round as a ball' of the mouse or rat fed on a certain synthetic diet.

The factor which protected from this attack and which we called 'atoxopyrimidine' was contained in rice-bran, meat, liver and yeast. No substance known up to 1943, such as vitamins or growth factors, could be substituted for the 'atoxopyrimidine'. As the extract of rice-bran contained 'atoxopyrimidine' in large quantity, we attempted to separate and purify this factor as follows. The water extract acidified with sulphuric acid was precipitated with phosphotungstic acid and the precipitate was treated with baryta. This procedure was repeated four times and the last precipitate of phosphotungstate was treated with acetone; the acetone-soluble fraction was recrystallized from acetone–water. This phospho-

tungstate, after treatment with baryta, protected the test animals from convulsions caused by 'toxopyrimidine', when fed to them for five days in a daily dose of 6–7 γ per gm. body-weight (sample 1). Further purification was attempted by counter-current distribution (sample 2) and paper chromatography (sample 3). All these samples showed a typical ultra-violet absorption spectrum resembling closely at all *p*H values that of uridine and, estimated from the extinction of the absorption spectra, these preparations of 'atoxopyrimidine '(samples 1–3) contained 23–30 per cent of uridine-like substance; but the fine structure of the peak of the absorption curve of the 'atoxopyrimidine' differed a little from that of uridine. 'Atoxopyrimidine' appeared to contain no phosphorus, sulphur or ribose. On paper chromatography, using ultra-violet light as detector, it showed R_F values of 0·15 with a butanol–water system, 0·63 with 80 per cent alcohol and 0·25 with butanol saturated with 1 per cent ammonia. The R_F values did not change even after heating with 6 *N* hydrochloric acid. 'Atoxopyrimidine' was adsorbed on acidic clay and only 10 per cent of the adsorbate could be eluted with *N* sodium hydroxide. It could be also adsorbed on activated animal charcoal, and 65 per cent of the adsorbate was eluted with *N*/2 sulphuric acid.

In order to test the influence of various vitamins and amino-acids upon the toxopyrimidine convulsions, vitamins and amino-acids were mixed and autoclaved and used for testing their physiological action. Some 'atoxopyrimidine' activity was found. Fractional purification revealed that the active principle contained in it is pyridoxamine, presumably formed from pyridoxine. An authentic sample of pyridoxamine showed a strong 'atoxopyrimidine' action. Its typical competitive nature may be explained by the fact that toxopyrimidine (I) and pyridoxamine (II) have in part the same structure (portion below the dotted line):



(I) (II)

The discovery of the effects of pyridoxamine have been confirmed by Dr. Y. Aramaki *et al.*, Takeda Pharmaceutical Research Laboratory, Osaka (private communication).

2-Methyl-4-hydroxy-5-hydroxymethylpyrimidine has also some 'atoxopyrimidine' potency, although its action is weaker than that of pyridoxamine. We are indebted to Dr. T. Matsukawa for supplying a sample of 2-methyl-4-hydroxy-5-hydroxymethylpyrimidine.

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Chromatophore Effect of Adrenocorticotrophic Hormone

ADRENOCORTICOTROPHIC hormone preparations produce an effect[1] similar to and even more pronounced than that of the pituitary chromatophore hormone intermedine[2]. When either of these hormones is injected into pale frogs, the melanophores 'expand' and the skin darkens. The identity of the two hormones has been assumed[3] but contested[4]. In the frog, however, this colour change occurs not only after injection of hypophysial extracts but also after administration of choline[5] and when the calcium concentration of body fluids is increased[6]. Investigating the chromatophore effect for the purpose of bioassay of adrenocorticotrophic hormone, we tried two preparations in fish the lipophores of which respond to intermedine but apparently not to the two other factors mentioned above[7].

Specimens of an Adriatic perch (*Serranus scriba*) and the minnow (*Phoxinus laevis*), kept under constant environmental conditions, received single subcutaneous injections of adrenocorticotrophic hormone. The British provisional standard and another preparation produced and standardized at the National Institute for Medical Research, London, were tested. The doses were dissolved in 0·2 ml. of 0·6 per cent saline. Ten or twenty fish were used per dose. Twenty *Serranus* and ten *Phoxinus* received saline as control. Within two hours after injection of adrenocorticotrophic hormone the lipophores 'expanded', the animals showing the bright colours of the 'nuptial dress'. Fig. 1 shows a dose response curve obtained with *Serranus scriba*, the logarithm of the dose being related to the percentage of injected animals in which the effect was found present. *ED* 100 was equal to 0·17 and 0·64 I.U. in *Phoxinus* and *Serranus* respectively.

The hypophysis of *Serranus scriba*, as distinct from that of *Phoxinus laevis*, contains no intermedine[7]. In *Serranus*, therefore, the chromatophore effect of the hormone injection was not due to liberation of the fish's own intermedine. But the present results do not exclude the possibility of the effect being due to contamination of the hormone preparations with intermedine[8]. Remarkably enough, another effect, the protection afforded by adrenocorticotrophic

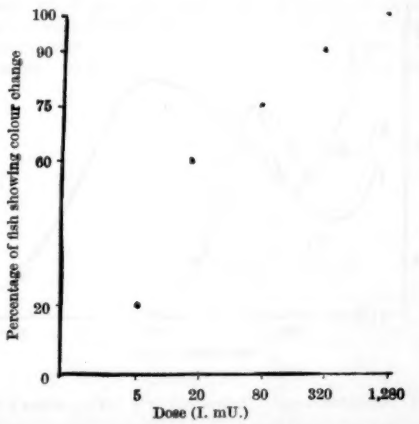

Fig. 1. Relation of log dose (international milliunits) of adrenocorticotrophic hormone to the percentage of fish (*Serranus scriba*) in which the colour change occurred

hormone against anoxia, was explained on the ground of posterior pituitary contamination[9].

We are indebted to Dr. W. L. M. Perry, director of the Department of Biological Standards, National Institute for Medical Research, London, for the generous supply of adrenocorticotrophic hormone.

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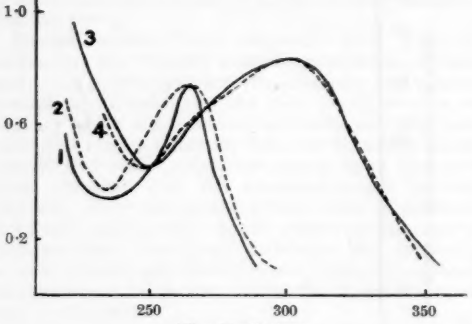
Biological Acetylation of *iso*Nicotinyl Hydrazide

Urine (210 ml.) from a tuberculous patient who received daily 200 mgm. of *iso*nicotinyl hydrazide was concentrated under diminished pressure to a syrup and was desalted by treatment with absolute alcohol. After evaporation of the solvent, the residual syrup was chromatographed on No. 50 Tōyō filter paper with water-saturated *n*-butanol as the solvent system, and the spots or the bands were observed under ultra-violet light (2537 A.). The bands which showed R_F values of 0·65 (*A*) and 0·74 (*B*) (the shadow of *A* was much stronger than that of *B*) were cut out, and the elutes from them were again tested by paper chromatography using several solvent systems as indicated in the accompanying table. This showed that *A* is 1-*iso*nicotinyl-2-acetyl hydrazine whereas *B* is the unchanged *iso*nicotinyl hydrazide. Confirmation was obtained by investigation of the ultra-violet absorption spectra of fraction *A*, which was first purified, by development on filter paper with 1 per cent ammonia – *iso*-propanol and *M*/50 phosphate buffer - saturated *n*-butanol system; fraction



Ultra-violet absorption curve

(1) 1-Nicotinyl-2-acetyl hydrazine: *p*H 1·4; λ(max.) 265; λ(min.) 236.
(2) Fraction *A*: *p*H 1·2; λ(max.) 265; λ(min.) 236.
(3) 1-Nicotinyl-2-acetyl hydrazine: *p*H 11·2; λ(max.) 301; λ(min.) 251.
(4) Fraction *A*: *p*H 11·6; λ(max.) 302; λ(min.) 250

Elute	Solvent systems 1	2	3	4	5
Fraction *A*	0·65	0·73	0·58	0·39	0·62
1-Nicotinyl-2-acetyl hydrazine	0·66	0·73	0·57	0·38	0·62

1: Water-saturated *n*-butanol.
2: 1 per cent Ammonia – *iso*-propanol (3 : 20).
3: *M*/50 Phosphate buffer - saturated *n*-butanol (*p*H 7·4).
4: 1 per cent Ammonia-saturated *n*-butanol.
5: *n*-Butanol – acetic-acid – water (4 : 1 : 5).

A has the same absorption curve as that of an authentic sample of 1-*iso*nicotinyl-2-acetyl hydrazine, as indicated in the accompanying figure.

Using the paper chromatographic technique, we were able to confirm that the whole homogenate of cattle liver can also acetylate the *iso*nicotinyl hydrazide.

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Systemic Insecticides and the Psyllid *Phytolyma lata* Walk.

The psyllid *Phytolyma lata* Walk. has been known for many years as a serious pest of the valuable timber tree *Chlorophora excelsa* (also known by the vernacular names iroko, mvule and odum) in tropical Africa. The insect attacks the new shoots on young trees, causing heavy gall formation, suppression of the terminal bud and severe stunting of the tree. Seedlings in nursery beds are very liable to damage, and many succumb to repeated attacks.

Contact insecticides have little effect on these insects owing to their gall-forming habits, but recent work using an insecticide with a systemic action has given promise that a satisfactory control could be developed. Six seedling plants growing in soil in metal pots were treated by watering the soil surface with a dilute solution of 'Hanane' containing 1·0 per cent dimefox (*bis*-dimethylamino fluorophosphine oxide). Application was at the rate of 50 parts per million on the total weight of soil and seedling, each pot receiving approximately 40 mgm. dimefox. Slight yellowing of the leaves was apparent at this level of dosage, but recovery was rapid and no sustained phytotoxicity was observed. A like number of similar plants was used as an untreated control. All the plants had been protected from attack and were entirely free from galls at the commencement of the experiment.

The plants were removed from the greenhouse and placed in close proximity to young *C. excelsa* saplings which bore very heavy galls from which adult psyllids were emerging. The test plants were watered carefully in the absence of rain and examined at weekly intervals.

After four weeks two of the untreated plants were showing gall formation and at five weeks all the untreated plants had developed galls. None of the treated plants showed any sign of damage or galls at the end of eight weeks. At nine weeks, however, small galls were seen on three of the treated trees, but the growth of these galls was stopped by a

second application of the chemical at 25 p.p.m. A subsequent examination of these galls showed that all the psyllids in them had been killed.

Lack of opportunity has prevented further work along this line, but it is felt that the above observations may be of interest to those engaged in the cultivation of this most valuable of African timber trees.

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Variation in Culture of *Fusarium culmorum* (W. G. Sm.) Sacc.

DURING the period 1950–51, studies were made of the germination of spores and mycelial development of a number of fungi isolated from the rhizosphere of healthy cocksfoot plants, *Dactylis glomerata*. Among those studied was *Fusarium culmorum* (W. G. Sm.) Sacc.

Macroconidia of this species were germinated in spore suspension at 20° C. and 25° C. for twenty-four hours, using a modification of van Tieghem's cell[1], with the following liquids: (*a*) glass-distilled water, (*b*) cocksfoot root exudate, (*c*) a water-soluble extract of soil derived from the roots of healthy cocksfoot plants, (*d*) a 1 per cent solution of potassium nitrate, (*e*) a 1 per cent solution of potassium chloride, and (*f*) a 1 per cent solution of calcium nitrate. Germination was 100 per cent in (*a*), (*c*) and (*d*) and 20–60 per cent in (*b*), (*e*) and (*f*). In (*a*), (*c*) and (*d*) fusions of germ-tubes were observed between 2–6 neighbouring macroconidia less than 80 μ apart (Fig. 1). Approximately 4 per cent of conidia were involved in 1 per cent potassium nitrate and soil extract solution, and 10 per cent in glass-distilled water. Growth of mycelium derived from fusion of macroconidial germ-tubes always led to the formation of variant forms of the fungus. The results from (*a*), (*e*) and (*f*) showed that neither the potassium ion nor the nitrate ion was directly concerned with fusion of germ-tubes. The effect of another factor, that of *p*H, was therefore investigated. The *p*H of glass-distilled water was 6·4, soil extract 5·4 and 1 per cent potassium nitrate 5·4.

The following experiment was set up to study the effect of *p*H on fusion of germ-tubes using glass-distilled water, the reaction of which was varied by addition of either decinormal sodium hydroxide or decinormal hydrochloric acid until a *p*H-range of 3·1 to 11·0 was obtained, the same method as before being used. The accompanying table summarizes the results.

EFFECT OF REACTION OF MEDIUM ON FUSION OF GERM-TUBES

*p*H of medium	Germination (per cent)	Fusion of germ-tubes (per cent)
3·1	0·0	0·0
4·0	94·0	0·0
5·0	100·0	0·0
6·0	100·0	4·0
7·5	100·0	20·0
8·5	86·5	80·0
9·0	100·0	10·0
10·0	100·0	0·0
11·0	69·3	0·0

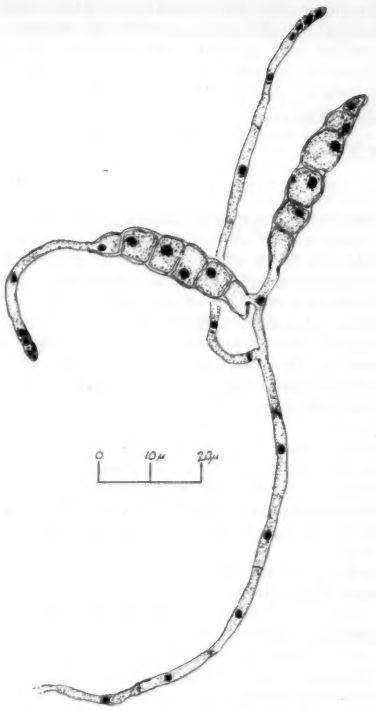

Fig. 1. Fusion of germ-tubes from two different macroconidia. Material stained in Heidenhain's iron-alum-hæmatoxylin, counter-stained with congo-red in clove oil; note hyphal tip and germ-tube tips are multinucleate, while the remainder of the cells are uninucleate

It is clear from the table that the reaction of the medium is an important factor in influencing fusion of germ-tubes. In liquid and on solid Carlier's glucose–peptone–agar[2] and Richards's solution-agar, conjugation of hyphæ on the same colony and of hyphæ from two different colonies was common within the *p*H range of 6–8 but did not always lead to the formation of variants (Fig. 2). It was also shown that growth of *Fusarium culmorum* in glucose–peptone solution and Richards's solution for 28 days at 25° C. caused a rise in the *p*H of the medium from 5·4 to 8·5 in the former and from 5·0 to 7·4 for the latter.

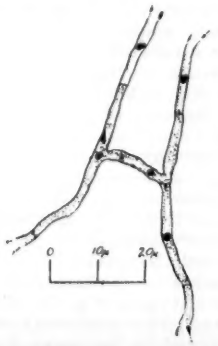

Fig. 2. Conjugation between two hyphæ, stained as for Fig. 1

Using solid media the increases in *p*H at the centre and margin of the colonies were as follows:

	Centre	Margin	
Glucose–peptone–agar	5·4	5·4	initial
	8·6	6·9	28 days
Richards's agar	5·0	5·0	initial
	7·6	7·0	28 days

If some of the sporing material was removed from both positions of the two media and allowed to germinate on fresh media, fusions of germ-tubes were more common with inoculum taken from the centre than from the margins of the 28-day old cultures.

Colonies developed from groups of fused germ-tubes gave four types of variants similar to those observed by Brown[3], namely, (1) pionnotal, (2) long-spore, (3) mycelial and (4) sporodochial types identical with the wild form, but with a much greater growth-rate.

Brown[4] found that conidia taken from the centre of an old colony of a *Fusarium* sp. grown on Richards's solution-agar gave rise to a high proportion of variants on germination; but he did not correlate this with the reaction of the medium or with germ-tube fusions.

I wish to thank Dr. S. G. Jones for his help and guidance throughout this work.

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Spiroidal Crystals of Zinc Sulphide

In the course of a comprehensive investigation of stacking disorders and polymorphism in zinc sulphide crystals grown by sublimation, we have encountered a new type of crystal form. The term 'spiroid' has been used for conveying the topological character of the habit, and to differentiate the phenomenon from the surface texture associated with a spiral dislocation mechanism of growth.

Two typical spiroids are shown in Figs. 1 and 2. The crystals grow with either single or multiple loops, and are precisely planar except for the slight displacement that results when the crystal crosses over itself. The crystals are usually about 0·5 mm. wide and 0·2 mm. thick; but the radius of curvature may vary from a fraction of a millimetre to several centimetres or more.

The crystallography of the forms has been established by X-ray and microscope techniques. The spiroids are hexagonal zinc sulphide, but disordered in the sense that there is a high density of stacking faults normal to the basal (00·1) planes. The 'spiroid axis' is [11·0], and the *c*-axis [00·1] of the hexagonal crystal is directed everywhere along a radius and in the plane of the loops (Fig. 3). A monochromatic X-ray photograph of a stationary crystal with the spiroid axis normal to the beam gives a layer line diffraction pattern characteristic of a single crystal

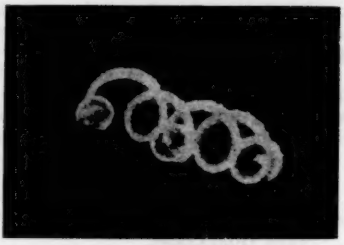

Fig. 1

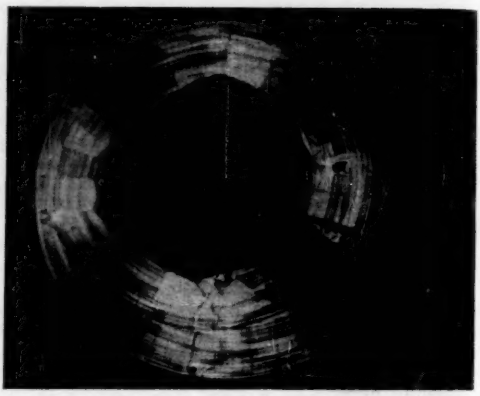

Fig. 2

rotating about [11·0]. A photograph with the beam parallel to the spiroid axis is similar in appearance to a spotty Debye pattern, and the texture in the diffraction rings shows the spiroid consists of individuals tilted about 0·2° with respect to their neighbours.

The following hypothesis is tentatively advanced to account for the phenomenon. The normal habit of hexagonal zinc sulphide is that of a needle with its major axis coincident with the crystallographic *c*-axis. We assume the habit here is modified (perhaps by selective adsorption on the basal planes) so that the crystal grows with its major dimension parallel to the *a*-axis. Zinc sulphide does not possess a centre of symmetry, and the unique (polar) axis is parallel to [00·1]. Because of the sense of the polar axis, edge dislocations located in the [00·1] planes with *a*-slip vectors may exist with a predominance of a single sign. Such a singular array of edge dislocations requires that there be extra planes of atoms entering the crystal from one face, and thus the curvature shown in Fig. 4*a* is produced. The final polygonization observed results from the minimization of the free energy of the system by the diffusion of edge dislocations to form small angle boundaries, as shown

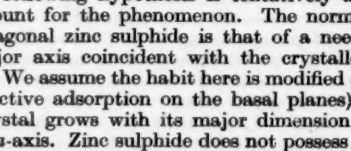

Fig. 3

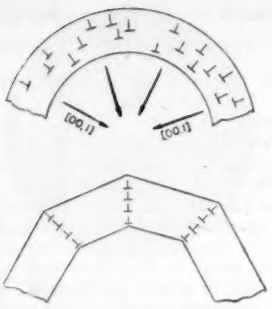

Fig. 4

in Fig. 4*b*, on a greatly exaggerated scale. From the degree of polygonization we estimate on the average an edge dislocation about every 200 atoms along the boundary.

We are indebted to Dr. W. W. Piper of this laboratory for making available to us these crystals, which he has grown by a vapour-phase technique, and to D. Hallgren for assistance in the measurements.

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Aug. 5.

A New Method of transporting Optical Images without Aberrations

The transportation of optical images has been carried out hitherto with the aid of lenses or mirrors or both. As with all optical systems, aberrations are introduced and the parts have to be aligned carefully; it seemed worth while, therefore, to search for a method by which no aberrations are introduced and which allows (strong) deviations from alignment without deterioration of the image. Consideration of the construction of the eye of some insects suggested another approach. If a bundle or sheaf of thin transparent fibres is cut off perpendicularly at both ends and an optical image is formed on one end, it will be seen at the other end, as the light entering one fibre can only leave this at the other end, provided leakage of light from one fibre to another of the bundle is prevented. Moreover, the cylindrical wall of each fibre must reflect the light as nearly completely as possible, because of the very numerous reflexions occurring when the fibres are thin compared to their length. Preliminary experiments, started in January 1950, have shown that coating the fibres with silver or any other metal yields an unsatisfactory transmission. A much better result was obtained when the fibres were coated with a layer of lower refractive index, which ensured total reflexion. This coating was isolated from the neighbouring fibres by a thin coat of black paint. In this way, flexible 'image rods' have been obtained with satisfactory transmission, a very good contrast in the end image, and with the possibility of using forms bent in any direction (up to at least 360°).

The first models were made of glass fibres. Much better transmission was obtained by means of plastic fibres, coated with either plastic of low refractive index or other transparent material of low refractive index. With an index of 1·52 for the core and 1·47 for the coating, the effective angular aperture of the light pencils entering and leaving the 'image rod' appeared to be about 1 : 1·8, which is ample for most practical applications, though a smaller difference of refractive indices would have been sufficient theoretically. Transmission, of course, is highly dependent on the transparency of the material used.

In order to obtain a high resolving power, the diameter of the fibres (or tubes) must be small. It appeared practicable to go down to 0·1 mm. for the core, though it seems possible to utilize smaller diameters. With the smaller diameters diffraction will play a preponderant part, and the fibres are then 'wave guides' for visible light. Of course, resolving power and overall transmission are reduced by the thickness of the coatings. The low-index coating must have at least a thickness of three to five times the wave-length. The length of the samples prepared in this laboratory varies from 6 to 20 cm.

Two obvious applications may be mentioned: cystoscopes and apparatus for the coding of two-dimensional pictures. Coding and decoding of two-dimensional pictures proved to be practicable.

The apparatus is different from the compound eye of an insect in that with the latter each 'fibre' has its own entrance lens, while with 'image rods' an image is formed on the entrance end by means of a system outside of the rod. Of course, entrance and exit surfaces of the rod may have another form than plane, for example, spherical.

This work was done under contract with the National Defence Research Council.

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May 21.

A Flexible Fibrescope, using Static Scanning

An optical unit has been devised which will convey optical images along a flexible axis. The unit comprises a bundle of fibres of glass, or other transparent material, and it therefore appears appropriate to introduce the term 'fibrescope' to denote it. An obvious use of the unit is to replace the train of lenses employed in conventional endoscopes. The existing instruments of this kind, for example, cystoscopes, gastroscopes and bronchoscopes, etc., consist of a train of copying lenses and intermediate field lenses. They are either rigid or have only limited flexibility. Moreover, the image quality of these systems is poor, since they consist only of positive lenses which give rise to a very large curvature of field. In existing gastroscopes the total number of lenses employed may be as many as fifty, and in consequence the light transmission is poor, due to the total glass path and the number of air–glass surfaces, in spite of blooming. Even more important in this respect, however, is the need to use small relative apertures for such instruments, this being necessary if acceptable definition is to be obtained with such large field curvature.

What was thought to be an entirely new approach to the problem of conveying images along a flexible axis was proposed by one of us (H. H. H.) as long

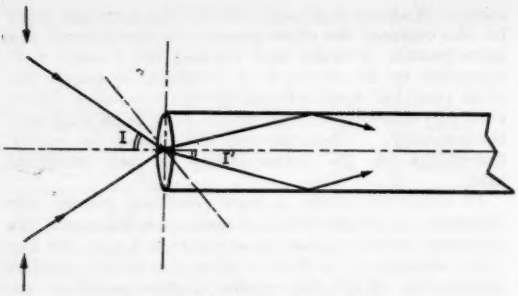

Fig. 1. Total reflexions in a single fibre

ago as 1949, although it was afterwards found that the idea had already been proposed by Baird in a British patent specification (1927 [1]). It is well known that light can be conducted along a curved glass rod due to multiple total internal reflexions at the walls of the rod. Very fine glass fibres should also possess this property and have the added advantage of flexibility. Theoretical considerations reveal that light should be safely conducted through a fibre of diameter 0·0005 in., below which diffraction effects become significant; the fibres act as wave guides, and energy escapes through the 'walls'[2]. The possibility of using fine fibres was experimentally verified by condensing light from a light source on one end of a fibre of borosilicate crown glass, 0·001 in. (= 0·025 mm.) in diameter and about 30 in. (= 750 mm.) long, and viewing the other end of the fibre with a low-power microscope.

It is easy to see by reference to Fig. 1 that the length of path along a multiply-reflected ray is simply equal to L sec I', where L is the axial length of the fibre and I' is the angle between the refracted ray in the fibre and the axis. Moreover, since the angle of incidence of this ray at the wall of the fibre is equal to $\frac{\pi}{2} - I'$, any ray which enters a fibre having a flat end will meet the walls of the fibre at less than critical incidence, providing the critical angle is greater than $\pi/4$. This requires that the index of refraction of the glass (μ) shall be greater than $\sqrt{2}$. The condition $\mu > 1{\cdot}41$ is satisfied by all the usual types of optical glass. Hence the loss of light along any ray occurs only because of absorption along a path of length L sec I'. The transmission of the fibre T is therefore given by $\log_e T = -\alpha . L$ sec I', where α is the absorption coefficient of glass.

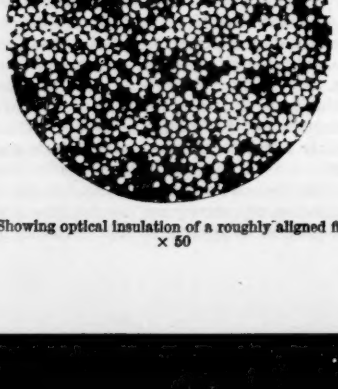

Fig. 2. Showing optical insulation of a roughly aligned fibrescope. × 50

The number of reflexions occurring in a length L is $\frac{L \tan I'}{D}$. For a ray at $I = 10°$ the number of reflexions in a fibre with $\mu = 1{\cdot}50$ and 0·001 in. diameter is 116 per in. of length. It is therefore essential that the surfaces of the fibre be very clean to avoid light being lost at each of these reflexions.

Having established that light could be guided along fine glass fibres with relatively small transmission losses, it was proposed in the new image conveyor to use a large number of regularly packed fibres, each of which could convey light from one element of the image formed on it to the other end of the bundle. This is a principle which we propose to call 'static scanning' in contrast to ordinary (dynamic) scanning of optical images. The success of 'static scanning' depends in practice on the optical insulation of each separate fibre being unaffected by the presence of other fibres close by it. Some preliminary experiments used a stack of a few hundred glass rods 1 mm. diameter and 25 in. long, and a roughly aligned stack of 0·001 in. diameter fibres also gave positive results, as may be seen in Fig. 2. Steps were then taken to construct a machine for making the first fibrescope unit.

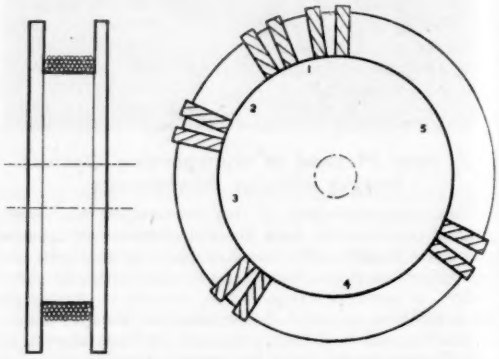

Fig. 3. Circular former used for aligning fibres

The method used for alignment depends on the availability of nominally infinite lengths of fibres of constant diameter of some optically transparent and homogeneous material. Very fine fibres are being made of material such as glass, quartz, nylons and polystyrene. However, of these, glass fibres seem to be the only ones which satisfy most of the requirements and are easily procurable. Glass fibres are preferred also because of their greater tensile strength as compared with that to be expected from the bulk material.

Long lengths of glass fibre were uniformly wound on a former having a peripheral groove of square cross-section, layer by layer, so that the nth layer was led to lie in the V grooves made by the $(n-1)$th layer. This is necessary to get close packing of the fibres, which is required both for mechanical stability and for obtaining the best resolving power. After winding the required number of layers, the bundle was gripped at different points by means of mechanical clamps (see Fig. 3), which were integral parts of the circular former. After tightening the clamps, the former itself was made to collapse so that the fibre stack slipped off the base, being held in position only by the clamps to yield different lengths of well-

Fig. 4. Fibrescope image of a simple test object. × 2

aligned fibres, as indicated by the numbers 1–5 around the periphery in Fig. 3. These numbers indicate the approximate length in inches of the lengths of fibres between successive cutting points. They make possible the production of a whole variety of lengths.

The former actually employed has a diameter of 5 in. with a groove of 0·25 in. square cross-section, and fibres of 0·0025 in. in diameter were wound on it. A 4-in. length of this bundle was used for testing the accuracy of alignment by passing a sharp image of a knife edge over one face of the bundle. The scanned image of the knife edge at the other end of the fibrescope showed no evidence of discontinuities arising from misalignment of the component fibres.

Light falling on any one fibre is distributed uniformly over the end face of the fibre on emergence. Moreover, if the image of a straight edge is formed on the object face of the fibrescope, the boundary of the edge will not generally lie across a single row of fibres the centres of which are in a straight line. In consequence, the image of the straight edge will be 'broken', but the discontinuity will never extend more than one fibre diameter into the dark portion of the image. Hence the size of detectable details should be of the order of twice the fibre diameter. In the present case, therefore, detail of 0·005 in. in size should be seen. This corresponds to a resolving power of 100 lines per in. on a line test chart. Tests were carried out on a 4-in. length of fibrescope from the above-mentioned bundle, and the theoretically expected resolving power of 100 lines to the inch was easily obtained.

The fibrescope was found to be robust, and a bending radius of less than 2 in. was easily achieved with the 4-in. length used, without any deterioration in the image quality. Fig. 4 shows a × 2 enlargement of the fibrescope image of a test object, the fibrescope having been curved into a quadrantal arc of a circle. Visually the image appeared to be of good contrast and well defined. Furthermore, up and down movement of the middle part of the fibre bundle by as much as 1 cm., the two ends remaining fixed, has no visible effect on the image quality.

This work has been financed by a grant from the Paul Instrument Fund of the Royal Society. We are indebted to Messrs. Fibreglass, Ltd., for their kindness in providing us with the fibres and for helpful discussion.

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Nov. 22.

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Application of the Hall Effect in a Semi-conductor to the Measurement of Power in an Electromagnetic Field

It is well known that if, in a piece of semi-conductor such as germanium or silicon, a magnetic field is set up along the z-axis, as defined by a Cartesian co-ordinate system, with current flow at right angles along the y-axis, then an electromotive force appears, due to the Hall effect[1] along the x-axis. This electromotive force at any instant is given by:

$$v = \left(\frac{R}{t}\right) I_c B \text{ volts}, \qquad (1)$$

where B is instantaneous flux density in gauss; I_c is instantaneous current in amperes; R is Hall coefficient in volt. cm. per ampere gauss (for 'n' type germanium R has a value of about 8×10^{-5}); and t is thickness in cm. along the z-axis of the sample of material exhibiting the Hall effect. The particular virtue of a semi-conductor like germanium or silicon for this purpose is that it possesses a comparatively large Hall coefficient and allows a substantial penetration of the field into the material even at ultra-high frequencies.

The power density, p, at any instant in an electromagnetic field, measured in watts per sq. cm. of cross-sectional area of the field, is given by:

$$p = EH \text{ watts per sq. cm.}, \qquad (2)$$

where E is instantaneous value in volts per cm. of the transverse component of the electric field; and H is instantaneous value in amperes per cm. of the transverse component of the magnetic field.

If, therefore, we arrange to produce through a piece of semi-conductor, placed in an electromagnetic field, a current I_c arising from the electric field E, then supposing in the first place we have a pure resistance circuit, the current I_c will be in phase with E and proportional to it. The magnetic flux density is $B = \mu H$, and if μ, the permeability of the medium, is constant, the Hall electromotive force will be a direct measure of the density of the power at any given point in the field. It is clear that the expressions (1) and (2) for the Hall electromotive force and the density of the power respectively are, apart from a constant term, exactly equivalent when, for example, I_c corresponds with E and B corresponds with H.

If for an alternating electromagnetic field the modulus of I_c is made proportional to the modulus of E, and the modulus of B proportional to the modulus of H, with the same phase difference between I_c and E as between B and H, then p is still obtained directly in terms of v. The total power can either be related to the density of power over a small area of the field, or obtained by integration.

The orthogonal spatial relationship which normally exists between the transverse components of E and H in an electromagnetic field enables these components to be used to produce the desired effect in the piece of semi-conductor, so that the Hall electromotive force then represents the longitudinal power.

The device is applicable to either steady, pulsating or alternating electromagnetic fields. When pulsating or alternating fields are used, it is necessary to obtain the true mean value in time of the Hall electromotive force taken over a complete period. Thus, represented as a function of time, the Hall electromotive force itself may be alternating or pulsating according to whether the electromagnetic field consists of, for example, a standing wave or a travelling wave; but in any event its true mean value over a complete

period gives a measure of the actual power, taking into account any phase difference between the transverse components of the electric and magnetic fields. Moreover, the direction of the power through the electromagnetic field is given by the sign of the Hall electromotive force, and the accuracy of the power measurement is independent of the wave-form of the field components. It may be convenient sometimes to allow a phase difference between B and H or the corresponding current when the field is associated with a wave-guide, and provide for this phase angle by an equal angle of the same sign between I_c and E, in the presence of a pure travelling wave.

While the device is of general application to the measurement of power or of energy transmitted in an electromagnetic field, whether supported by a guide or in free space, it is particularly suitable for use with a transmission line, a cable or a wave-guide. In order to obtain a conveniently measurable Hall electromotive force with a power of a few watts, it is desirable when using a semi-conductor like germanium to operate the device in a relatively strong magnetic flux, since the current I_c is limited by the need for avoiding any substantial power loss in the semi-conductor and consequent rise in temperature. Moreover, there is a tendency for semi-conductors to become saturated in very strong electric fields.

For a free-space plane wave, the ratio E/H is 377 ohms; but when conductors are used as a guide, it is possible to alter this ratio by increasing H at the expense of E and bringing about a more favourable situation for power measurement by the application of the Hall effect. The magnetic flux density B can also be increased relative to H by providing a medium of high permeability over the greater part of the magnetic circuit. There is also the possibility of increasing the sensitivity of the device with alternating fields by placing it in a resonant system, such as a resonant window or cavity of the kind employed at ultra-high frequencies.

It is important in this application to eliminate so far as possible any residual rectifier action, leading to an output at the Hall contacts, in the absence of power flow. With care, non-rectifying connexions to the semi-conductor can be substantially achieved, and using relatively strong magnetic fields any disturbances of the Hall e.m.f. can be made negligible.

A simple application of the device is, for example, to a pair of heavy-current bus-bars between which is supported a germanium crystal shunted across the circuit and having leads from the Hall contacts brought out to a high-resistance moving-coil galvanometer.

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Stress Relaxation in Wood

Kitazawa[1] investigated stress relaxation in wood maintained at a constant compressive strain for *c.* 600 min., and contended that Maxwell's relation:

$$F = F_0 \exp(-t/\tau), \quad (1)$$

where F is the applied force at time t, F_0 the initial force on the specimen and τ the relaxation time of the material, did not fit his experimental data. He proposed instead an empirical equation:

$$F = F_1(1 - m \log t), \quad (2)$$

where F_1 is the force after unit time and m a constant. The applicability of this equation for times greater than the range of the experiment was not questioned, and the equation has recently been quoted by Hearmon[2], also without restricting the time-range.

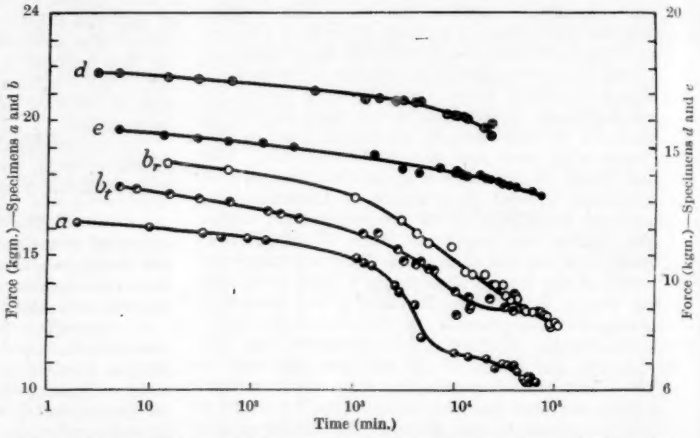

Fig. 1. Force required to maintain constant deformation of wooden beam, plotted against time. Specimens maintained at equilibrium moisture content, except *e*, which was kept green. Curves b_t and b_r represent the behaviour of the same specimen in consecutive tests, loaded first on the tangential face (b_t) and then on the radial (b_r).
a: $F_0 = 16{\cdot}4$ kgm.; b_t: $F_0 = 17{\cdot}8$ kgm.; b_r: $F_0 = 19$ kgm.; *e*: $F_0 = 16$ kgm.; *d*: $F_0 = 17{\cdot}8$ kgm.

Experiments conducted in this laboratory have aimed at relating the creep in beams of hoop pine (*Araucaria cunninghamii* Ait.), bent under constant load, to the stress relaxation at constant deformation over a period of 10^5 min. (two months). Details will be published later. The stress relaxation data at 21° C. are shown in Fig. 1, plotted on a logarithmic time-scale as in Kitazawa's paper. The differences in the curves are related to the observed incidence of compression wood in some specimens. However, they all depart from equation (2), and the force can be represented much better by the sum of exponential terms with various relaxation times; for example, curve (*a*) closely follows the function:

$$F = F_0 [0{\cdot}04 \exp(-t/7) + 0{\cdot}31 \exp(-t/5{,}000) + 0{\cdot}65 \exp(-t/3{,}000{,}000)], \quad (3)$$

t being measured in minutes.

The use of more than one retardation or relaxation time was first advocated by Thomson[3] and by Wiechert[4]. Wiechert[5] later discussed the shape of stress relaxation curves plotted against logarithm of time and derived an approximate formula similar to (2) for a limited range of time near the maximum of a normal distribution of relaxation times. The time limits between which the approximation is adequate depend on the width of the distribution.

Our experiments cannot be directly compared with Kitazawa's work, since the species tested and the modes of straining differ. However, it appears that for the general description of stress relaxation in wood, a linear relationship between stress and (log) time is inadequate, and a relaxation spectrum must be used.

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Aug. 25.

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A Supernumerary Chromosome in *Locusta*

THE chromosomes of *Locusta migratoria* normally comprise eleven pairs of autosomes ranging from 1·2 μ to 5·3 μ, with two *X*-chromosomes in the female and one *X* in the male[1]. In 1934, however, Itoh[2] described locusts in a Japanese population which contained an additional chromosome, present in variable numbers and supernumerary to the normal complement. Recently, we have found such supernumerary chromosomes in a stock used in this Department. Each extra chromosome has a subterminal centromere and is slightly larger than any member of the three smaller autosome pairs. In these and other respects the supernumeraries appear to be similar to those found by Itoh in Japan. Dr. C. E. Ford and Mr. J. L. Hamerton, of the Radiobiological Research Unit, Harwell, and Mr. C. G. Elliott, of the Botany School, Cambridge, have kindly informed us that they too find supernumerary chromosomes in locust stocks related to our own.

The supernumerary chromosomes, which are largely heterochromatic, are common in our stock. Thus in one sample of twenty-seven males, representing the progeny of five single pair matings, twelve carried supernumeraries in spermatogonial nuclei. The highest number of extras seen in a nucleus was four. Supernumeraries never pair with any of the normal chromosomes at meiosis, but when two of them are present in the same nucleus they almost invariably form a bivalent by means of a single chiasma in the proximal half of the bivalent. No chiasmata form in the distal region, which appears to be completely heterochromatic. Trivalents have also been seen in nuclei with three extras, the chiasmata in all cases being localized in the proximal region. It is evident that the supernumeraries in the stock are all homologous with one another. A single or unpaired supernumerary either divides late at the first anaphase with consequent loss at the second division, or at the second anaphase without loss. From counts at second telophase, we estimate that where the spermatogonia each contain one extra chromosome, as many as 20 per cent of the extra chromosomes may be lost at meiosis.

Supernumeraries in spermatogonia vary in number not only between individuals. There may be considerable variation between cells within one testis, as shown in the table. This kind of variation probably results from non-disjunction at mitosis. Whatever the cause, it indicates that the extra chromosomes are inefficient during mitosis. There is other evidence of their inefficiency. In a small proportion of meiosis in four males, a supernumerary chromosome was broken into two parts, the break in each case being in the vicinity of the centromere.

Locusta migratoria. *a*, Early diplotene, with a supernumerary bivalent, deeply stained, and having one proximally localized chiasma; *b*, late diplotene, with one supernumerary chromosome. The supernumeraries are indicated by arrows. (× 1,740)

FREQUENCIES OF SPERMATOGONIAL NUCLEI WITH 0, 1 AND 2 SUPERNUMERARIES IN TWO MALES

Male	No. of supernumeraries per cell		
	0	1	2
A	6	13	3
B	1	20	4

We have found as yet no correlation between the presence of supernumeraries and the expression of a number of morphological characters which have been examined, such as body-weight, length of elytron, length of posterior femur and breadth of the head. It is clear, however, that to persist in a population a supernumerary that is mechanically inefficient and subject to loss at meiosis cannot be genetically completely inert[3]. Its genetic effects on the organism must compensate for its inefficiency in the cell. What these benefits are, and at what stage of the life-history they are manifested, remain to be determined.

Itoh's Japanese locust population is the only one reported with supernumerary chromosomes[4], and it is remarkable that the supernumeraries we have

described should apparently be identical to those found by Itoh in Japan: it may prove that supernumeraries of this type are not uncommon. On the other hand, it is possible that by coincidence the supernumeraries arose separately in the Japanese population and the Sudanese population from which our stock is descended. Alternatively, the chromosome complement which includes the extra chromosomes may, at one time, have been widespread, and the Japanese and Sudanese populations may be survivors of this type. In these and other localities where they might occur the survival of supernumerary chromosomes could be explained by an adaptive advantage conferred by supernumeraries in particular stocks in these limited environments.

The locust stocks were obtained by the courtesy of Dr. B. P. Uvarov from the Anti-Locust Research Centre, which provides financial support to the study of the genetics of locusts carried out in this Department. One of us (A. J.) receives a grant from the Anti-Locust Research Centre.

We are greatly indebted to Dr. C. E. Ford and Mr. J. L. Hamerton for providing useful information and for valuable discussion in connexion with this work.

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False Positive Results in the Diagnosis of Rare Blood-Group Antigens

Mr. I. Dunsford's communication in *Nature* of December 5, p. 1059, directs attention to the importance of the detection of the rare sub-group A_4, when uncommon blood-group antigens are being considered, such as family or 'private' antigens, which many workers have described.

In the diagnosis of these rare blood-group antigens, false positive results due to polyagglutinability of the red cells should be considered. Polyagglutinability of red cells is a condition in which a person's erythrocytes, while not usually being agglutinated by their own serum, are agglutinated by other normal sera of homologous *ABO* group; this agglutination occurs on slides, in tubes, or in capillaries, at room temperature.

Reepmaker[1] has recently documented twelve cases which have been described and he adds another case. I myself have seen five cases, all of which were observed as a result of difficulties arising during *ABO* typing. When a rare blood group is thought to be detected, such as group A_4, one should bear in mind that this might possibly be a case of polyagglutinability of the red cells, and they should be tested with a large number of normal sera from donors of compatible *ABO* group. This is necessary because the percentage of compatible sera with which the affected cells react varies, in my experience, from 9 to 60 per cent. False positive results due to this cause may also occur during the detection of other rare blood-group antigens.

Dunsford gives the frequency of A_4 blood as 1 : 30,000; it is probable that polyagglutinability of the red cells is a rarer condition, but its true frequency is unknown.

It is assumed that the samples of blood which are examined for these rare blood groups are collected aseptically and have remained sterile from the time of collection until tested. The examination of infected cell samples can give rise to false positive results similar to those which occur with polyagglutinable red cells.

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'Hidden' Anti-*Rhesus* Saline Antibodies

A *Rhesus* antibody of any given specificity, for example, anti-*D*, occurs in two common forms or states: as a 'saline antibody' that will agglutinate red cells suspended in saline, and as an 'albumin antibody' that will agglutinate red cells only if they are suspended in a colloid medium or if they are first treated with a proteolytic enzyme. The blood of a sensitized woman may contain either or both, but only the albumin antibody is demonstrable by standard methods in the blood of her newborn baby. Recently, we found saline anti-*Rhesus* antibodies in the blood of three such babies, following replacement transfusion in two and simple transfusion in one. Albumin antibody but no saline antibody was demonstrable in the blood of each of the three prior to transfusion. None of the donors' bloods contained anti-*Rhesus* saline antibodies or irregular agglutinins of any other type.

As an example, newborn baby C., with an albumin anti-*D* antibody of titre 16 and no saline antibody in its cord blood, received a replacement transfusion from donor S. At the end of the transfusion the titre of the antibody in the baby's blood was 4 in albumin, 8 in saline. On further investigation, we found that the change in the antibody in the cord blood could be reproduced in the test-tube. When one part of serum of donor S. was incubated with one part of cord serum of baby C., for 30 min. at 37° C., the antibody titre was 16 in albumin, 32 in saline. A similar experiment was carried out with the serum of donor S. plus the serum of Mrs. C., with similar results. Development of a saline antibody in the test-tube by this means has been carried out with a number of other sera.

We are calling serum of a person such as donor S. an 'antibody-transforming' serum, and the saline antibody that developed a 'hidden saline' antibody. Investigations to date indicate the following.

(*A*) Concerning antibody-transforming sera: (1) Perhaps one in ten normal sera has antibody-transforming activity in it to some extent. (2) Antibody-transforming activity is somewhat weakened but not abolished by heating at 56° C., for up to two hours. (3) Antibody-transforming activity is not affected by repeated freezing and thawing. (4) When *Rhesus*-positive red cells are incubated with an antibody-transforming serum, they are not altered so as to be agglutinated by an albumin antibody in the capillary or on the slide. (5) When *Rhesus*-positive red cells are sensitized by an albumin antibody and then washed three times in saline, an antibody-transforming serum will not agglutinate them.

(*B*) Concerning the 'hidden saline' antibodies: (1) We have so far demonstrated hidden saline anti-

bodies of the specificity anti-*D* only. (2) The hidden saline antibodies are not measurably weakened by heating at 56° C. for two hours. (3) A hidden saline antibody of specificity anti-*D* will not agglutinate *D*-positive cells that have been blocked by an anti-*D* blocking antibody. (4) Not every serum that contains an albumin antibody will develop a hidden saline antibody when incubated with equal parts of an antibody-transforming serum. (5) In sera that do develop a hidden saline antibody, the titre of that antibody may be equal to, or less than, the original albumin titre. (6) The cord blood of a baby of a woman with both saline and albumin anti-*D* will not necessarily develop a hidden saline anti-*D* when incubated with an antibody-transforming serum.

It is our impression that antibody-transforming sera do not transform albumin antibodies into saline antibodies, but that the sera of some sensitized women and of their babies contain hidden saline antibodies which are made manifest by the addition of antibody-transforming serum. Our evidence so far does not indicate how this is brought about.

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Aug. 27.

A Simplified Micromanipulator

THIS communication describes a micromanipulator which is capable of the finest movements in three dimensions, and which can be constructed at negligible cost in a few minutes. The principle used is that a force applied by the hand, to move the micro-instrument against a resistance which can be made as large as needed, can produce a movement of the needle which may be controlled to within about a micron. The degree of control possible is already familiar in the ordinary microscope-stage movement. The delicacy of adjustment can be much improved by increasing the viscosity of the grease between the sliding surfaces.

The small movements are obtained by pushing, by hand, glass plates sliding over others and lubricated by 'Vaseline' of suitable viscosity. Two pieces of microscope slide are cemented at right angles with sealing wax, *W*, and the inverted T-shape so formed is placed on a drop of 'Vaseline' at one end of the slide holding the object which is to be manipulated. The microneedle is cemented with sealing wax *W* to another piece of microscope slide, and this is attached by 'Vaseline' to the vertical leg of the T (see Fig. 1).

The vertical fin is grasped by finger and thumb and the needle pushed in the desired direction. Vertical movement is produced by sliding the glass attached to the needle up and down with the thumb. A piece of sealing wax *W* cemented about 2 cm. above the needle assists gripping. It is difficult without practice to move the needle vertically without simultaneously altering the horizontal position. This can be obviated by first setting the needle at the desired height, and then moving it in the two horizontal dimensions by grasping the base of the T-holder instead of the vertical fin. By grasping a handle extending backwards a few inches along the needle axis, the finest movements in the vertical dimension can be made.

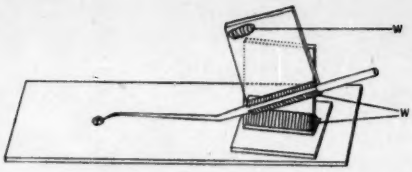

Fig. 1. Diagram of micromanipulator. Tip of needle and drop containing micro-organism are not drawn to scale. *W* = sealing wax

Ordinary 'Vaseline' is only sufficient to produce coarse movements; the whole success in producing fine movements is due to the use of lubricants of higher viscosity. These can be produced by melting together 'Vaseline' and paraffin wax in various proportions. A mixture containing about 60 per cent paraffin wax was found to permit control of the needle point to about 1 micron (though some experiment with the ratio is advisable owing to the different properties of various grades of paraffin wax and 'Vaseline', and their dependence on the operating temperature); backlash was found to be absent.

There is no drift in the two horizontal directions, and under gravity in the vertical direction with a light needle it is negligible (the tip not moving out of focus in half an hour) during the time of the experiment, since the weight of the moving part is small compared with the force exerted by the thumb to move it. Probably a slight thixotropy in the grease sets the needle in place once movement has stopped.

Movement of each instrument is controlled in three dimensions by one hand, and the effect is similar to that of the de Fonbrune instrument, except for the reversal in the microscope. With a little practice, skill in using it improves.

It is easy to see how this manipulator principle can be exploited to as many ends as the experiment demands. Two such instruments can be placed on one microscope slide, and others can be placed on the microscope stage itself, so as to move independently of the slide. Alternatively, by using a square glass plate instead of a slide, four or more instruments—hooks, needles, pipettes, electrodes—may be used at once. With microelectrodes, the problems of insulation are reduced through the complete absence of metal parts and the simplicity of the apparatus.

By tilting the needle slightly upwards, it can be used in a damp chamber on the under side of a coverslip so as to permit the high power of the microscope to be used. If a long-focus objective is used, the drop containing the organism may be simply covered with oil.

With this instrument various operations have been carried out: measurements of electrical potentials arising from various parts of the surface of the amœba; microinjection into the amœba; enucleation and various other microsurgical procedures; isolation of single cells into small drops; measurements of cell volume by sucking the cells into cylindrical tubes, etc.

Above all, this method of operation is useful where many different manipulators are required at once.

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Sept. 15.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, January 5

PHYSICAL SOCIETY, ACOUSTICS GROUP (at Trinity College of Music, 11 Mandeville Place, London, W.1), at 5.15 p.m.—Mr. Hope Bagenal: "Cathedral Acoustics".

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Norman Swindin: The George E. Davis Memorial Lecture.

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. K. Kandiah: "A Scaling Unit Employing Multi-Electrode Cold-Cathode Tubes" and "A Sensitive Pulse Trigger Circuit with a Stable Threshold"; Mr. F. S. Goulding, Mr. J. C. Hammerton, Mr. M. G. Kelliher, Mr. A. W. Merrison and Mr. E. R. Wiblin: "The Development of a Neutron Spectrometer for the Intermediate Energies".

Wednesday, January 6

INSTITUTE OF METALS (at the University, Edgbaston, Birmingham), at 10.30 a.m.—Informal Discussion on "Lubricants for Metal Working Operations in the Non-Ferrous Metals Industry". Chairman: Mr. W. J. Thomas.

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Photographic Society, 16 Princes Gate, London, S.W.7), at 3.30 p.m.—Dr. W. C. Price: "Modern Theories of the Colour of Organic Molecules"; Dr. R. W. G. Hunt: "The Use of Coloured Couplers to overcome Unwanted Absorptions in Colour Photography".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 6.45 p.m.—Education Group Discussion: "The Future Development of the National Certificate and Diploma Courses".

Thursday, January 7

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 3 p.m.—Sir Leonard Bairstow, F.R.S.: "The Fun of Finding Out in Flying" (Lecture to Young People).

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Alan Davidson: "Some Scandinavian Birds", illustrated with photographs, and a colour film of Lapland by Mr. Arthur Christiansen.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. H. Leyburn: "Continuity of Electricity Supply" (Parsons Memorial Lecture).

Friday January 8

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College, Prince Consort Road, London, S.W.7), at 10.30 a.m.—Papers on "The Potato Root Eelworm".*

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

PRESENTATION OF TECHNICAL INFORMATION, DISCUSSION GROUP (in the Anatomy Theatre, University College London, Gower Street, London, W.C.1), at 6 p.m.—Mr. A. W. Haslett: "Some Problems of Technical Editing".

Saturday, January 9

JOURNAL OF EMBRYOLOGY AND EXPERIMENTAL MORPHOLOGY (in the Department of Anatomy, University College, Gower Street, London, W.C.1), at 10 a.m.—Scientific Papers.* (Further Meetings on January 11 and 12.)

BRITISH MYCOLOGICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL or SENIOR SCIENTIFIC OFFICER (with an honours degree in engineering, physics or mathematics, and some engineering experience), at the Atomic Energy Research Establishment, Harwell, for fundamental studies of nuclear reactor design involving basic engineering investigations in conjunction with nuclear physics aspects—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 1/103/23 (January 9).

CHAIR OF MINING—The Registrar, The University, Sheffield 10 (January 14).

READERSHIP IN CHEMICAL PATHOLOGY tenable at the Royal Free Hospital School of Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 14).

AGRICULTURAL ZOOLOGIST at the University College of Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (January 15).

DONALD POLLOCK READERSHIP IN ENGINEERING SCIENCE—The Registrar, University Registry, Oxford (January 16).

LECTURER IN PHYSIOLOGY AND PHARMACOLOGY in the Department of Pharmacy, College of Technology, Liverpool—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (January 20).

LECTURER (graduate in science or technology and with a good knowledge of the theory of structures) IN STRUCTURAL ENGINEERING, to undertake research work on structures, and to assist in lecturing and laboratory work in structural engineering—The Registrar, College of Technology, Manchester 1 (January 20).

PROFESSOR (with high academic qualifications, and practical works experience in ferrous metallurgy) OF CHEMISTRY AND METALLURGY, an ASSISTANT PROFESSOR OF APPLIED MECHANICS, and LECTURERS IN APPLIED MECHANICS (2) at the Royal Naval College, Greenwich, London, S.E.10—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 4277/54 (January 21).

CHAIR OF HEAVY ELECTRICAL ENGINEERING, tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 29).

READERSHIP IN PRODUCTION ENGINEERING at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 29).

CHAIR OF GEOGRAPHY—The Registrar, University College, Singleton Park, Swansea (January 30).

LECTURER or ASSISTANT PROFESSOR (with degree of Ph.D., or equivalent, and with special training in embryology and comparative anatomy) OF ZOOLOGY—The Dean, Faculty of Arts and Science, University of Alberta, Edmonton, Canada (February 1).

LECTURER IN APPLIED MATHEMATICS at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, February 8).

AGRICULTURAL OFFICERS (Soil Conservation) (with either a University degree involving specialization in soil conservation with at least one year's practical postgraduate experience, or a university degree in agriculture or an allied subject with at least two years postgraduate study or experience of soil conservation) in the Gold Coast Local Civil Service, for duties connected with land-use and anti-erosion measures—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/13/04.

ASSISTANT METEOROLOGIST (with H.S.C. or equivalent in mathematics and physics, and with forecasting experience) with the Mauritius Government—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M3B/33530/TA.

PHYSICISTS (with good honours degree and some experience or training in research, not necessarily in textile research) to work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, near Manchester.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Cathodic Protection of Pipelines and Storage Tanks. By V. A. Pritula. Pp. vi+160. (London: H.M. Stationery Office, 1953.) 10*s.* net. [1311

National Smoke Abatement Society. Industrial Smoke Prevention and National Fuel Policy. Excerpts from the Report of the Committee on National Policy for the Use of Fuel and Power Resources. Pp. 8. 6*d.* Domestic Smoke Prevention and National Fuel Policy. Excerpts from the Report of the Committee on National Policy for the Use of Fuel and Power Resources. Pp. 8. 6*d.* [1311

Department of Scientific and Industrial Research: Building Research Station. National Building Studies. Research Paper No. 18: Investigations on Building Fires. Part 6: The Fire Resistance of Reinforced Concrete Columns. By Dr. F. G. Thomas and C. T. Webster. Pp. iv+80+4 plates. (London: H.M. Stationery Office, 1953.) 3*s.* net. [1311

Other Countries

Polska Akademia Imiejetności. Starunia Number 30: Plejstoceńskie ryjkowce (curculionidae, Colept) z doliny Ziembowki. By St. Smreczyński. Pp. 10. (Krakow: Polska Akademia Imietetności, 1953.) [1111

Polska Akademia Nauk. Archivum Elektrotechniki. Tom 1, Zeszyt 1, Rok 1952. Pp. ii+78. (Warszawa: Wydawnictwo Zakladu badania Drgan i Zakladu Elektroniki, 1953.) [1111

Academia Nazionale dei Lincei. Atti dei Convegni. Convegno di Scienze Fisiche Matematiche e Naturali, 14–19 Settembre 1952. Tema: Problemi della Fisica Solare. Pp. 332. (Roma: Academia Nazionale dei Lincei, 1953.) 3000 lire. [1111

United States: Department of the Interior. Geological Survey. Professional Papers. No. 244: Eocene and Oligocene Larger Foraminifera from the Panama Canal Zone and Vicinity. By W. Storrs Cole. Pp. iii+42+28 plates. 1.25 dollars. No. 248–A: Mica Deposits from the Southeastern Piedmont. Part 1: General Features. By Richard H. Jahns, Wallace R. Griffiths and E. Wm. Heinrich. Pp. v+102. 1.25 dollars. No. 248–C: Mica Deposits from the Southeastern Piedmont. Part 3: Ridgeway–Sandy Ridge District, Virginia and North Carolina. Part 4: Outlying Deposits in Virginia. By Wallace R. Griffiths, Richard H. Jahns and Richard W. Lemke. Pp. iv+141–202. n.p. No. 248–E: Mica Deposits of Southeastern Piedmont. Part 7: Hartwell District, Georgia and South Carolina. Part 8: Outlying Deposits in South Carolina. By Wallace R. Griffiths and Jerry C. Olson. Pp. iv+293–326. 50 cents. No. 252: The Hydraulic Geometry of Stream Channels and Some Physiographic Implications. By Luna B. Leopold and Thomas Maddock. Pp. vi+58. 35 cents. (Washington: Government Printing Office, 1952 and 1953.) [1311

Travaux de l'Institut Scientifique Cherifien. No. 10: An Ornithological Journey in Morocco in 1951. By Dr. David Bannerman and Jane W. M. Bannerman. Pp. 68. (Tanger: Editions Internationales, 1953.) [1611

Indian Forest Bulletin No. 170 (New Series). Wood Seasoning. The Seasoning Behaviour of Indian Timbers, Part 2 (Kiln Drying Schedules). By M. A. Rehman. Pp. ii+7. 1/5 annas; 6*d.* Forest Research Institute, Dehra Dun. Indian Forest Leaflet No. 134: (Statistical): Statistical Methods in Forest Research. By Dr. K. R. Nair. Pp. 7. 7 annas; 8*d.* Indian Forest Leaflet No. 135 (Entomology): Protection of Plywood in Storage on Godowns Against *Lyctus* Beetles by treatment with Dichioro-Diphenyl-Trichloroethane (D.D.T.) and Benzene Hexachloride (B.H.C.). By Dr. P. N. Chatterjee. Pp. 4. 5 annas; 6*d.* (Delhi: Manager of Publications, 1953.) [1611